The MINING CONGRESS JOURNAL

THIS ISSUE

FOR many years the American Mining Congress has been a leader in the development of modern mining practice. It has fostered a closer working relationship between those who manufacture and those who use equipment. It has conducted open forums on operating practice at its coal conventions and expositions, and to a lesser degree at its metal mining meetings. It was the original sponsor of Standards for Mining Methods, Practice, and Equipment, and has completed many standards approved and endorsed by the American Standards Association. It conducts studies in behalf of operating efficiency and at the present time has 17 committees gathering and studying data on every phase of production.

All of this activity has materially advanced modern mining methods. Today the mining industry is notable for its efficiency in production. The manufacturers of equipment have played no small part in this remarkable progress, and this issue is dedicated to their achievements. A closer cooperation between producer and manufacturer will undoubtedly bring about still greater efficiency.

THE EDITORS

JULY
1935

METAL MINING

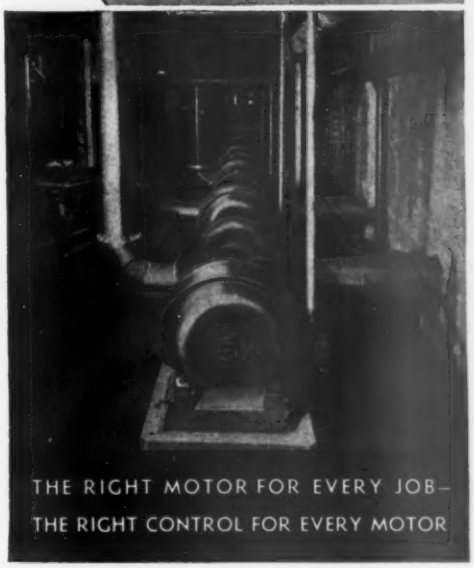
CONVENTION and EXPOSITION

Palmer House, Chicago, Illinois

September 23-27, 1935

WHICH MOTOR for Jobs Where There are SPLASHING LIQUIDS?

Wound-rotor induction motors for cranes, hoists, and other high-starting-torque jobs; also for speed control on fans
Gear-motors—compact, efficient low-speed drives for your conveyors, low-speed pumps, machine tools, etc.
The G-E Splashproof Motor
Squirrel-cage induction motors*—simple, sturdy motors for your run-of-the-plant jobs
*Typical of Frames 326 and smaller
Direct-current motors—use them where you want unusually fine speed control, or where your power is d-c.



IF your machinery must be washed down, or if it operates where there are splashing or dripping liquids or falling particles, you can save money and get longer motor life and more dependable service if you use G-E splashproof motors and control for your jobs. Squirrel-cage induction, wound-rotor induction, synchronous, direct-current—whatever type of motor your job requires, we can supply you with the RIGHT motor, protected against splashing liquids or falling particles.

Have you a job for a splashproof motor in your plant? If so, why not see a sales engineer in the nearest G-E office? He's well grounded in motor application, and back of him is General Electric's more than 40 years' experience in the design, manufacture, and application of motors for industry. All this experience is available to help you get the most profitable solution of your drive problems. General Electric, Schenectady, N. Y.

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GENERAL ELECTRIC

The MINING CONGRESS JOURNAL

JULY 1935

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NUMBER 7

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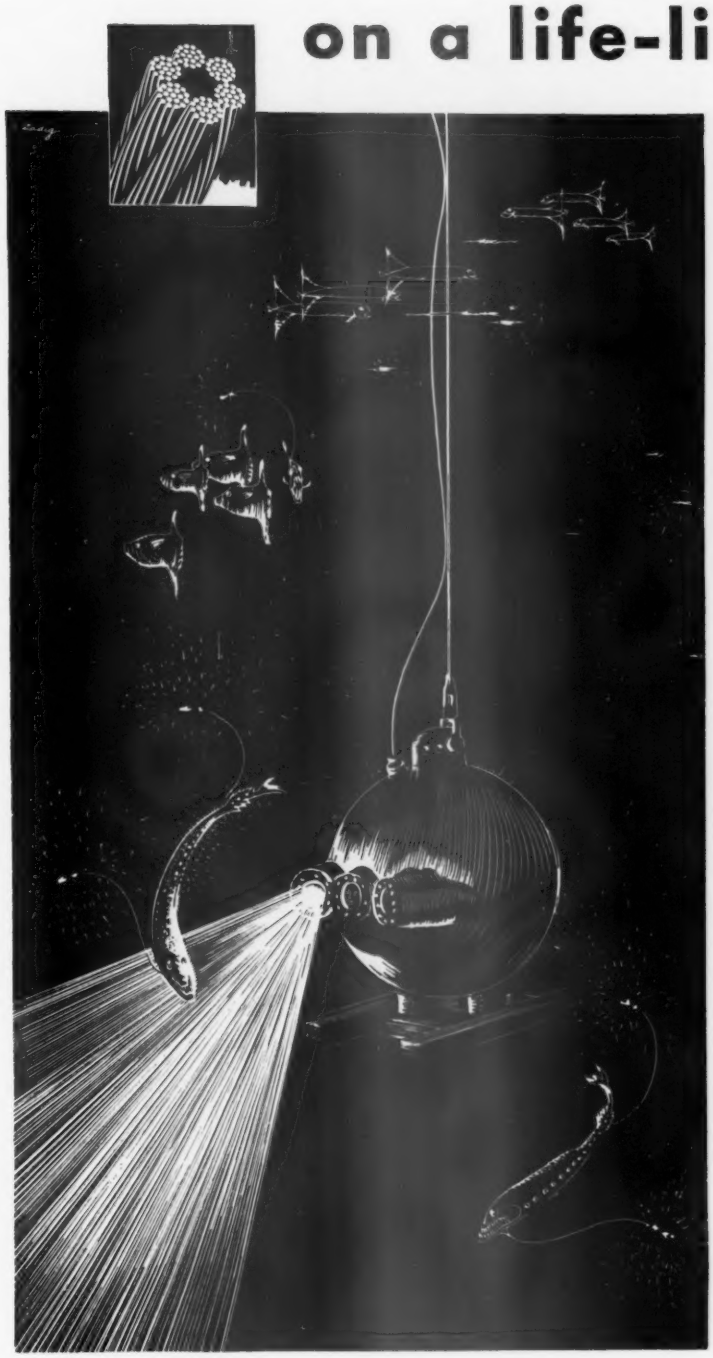
A Half Mile Dive
on a life-line of steel



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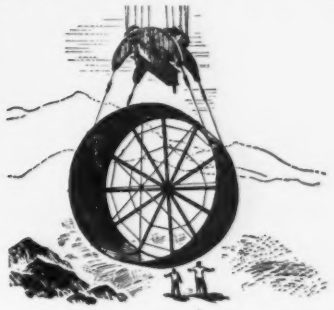

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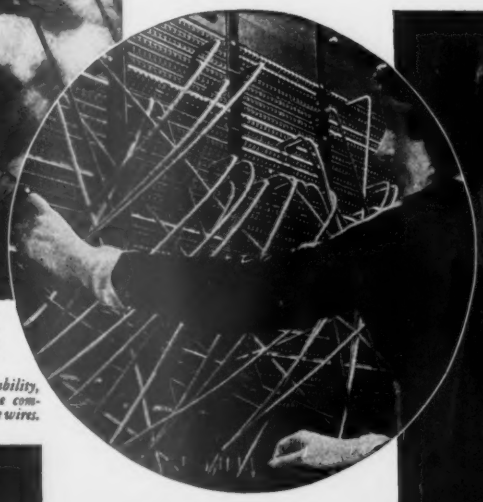

Because of their unfailing dependability, Exide Batteries are used by telephone companies to help carry your voice over the wires.

Railroads use Exides, not only for dependable, low-cost signal power, but for car-lighting, air-conditioning, Diesel starting, and materials handling trucks.

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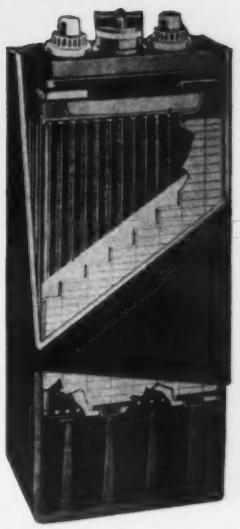

Showing the unique construction of Exide-Ironclad positive plates. Slotted rubber tubes retain the active material, while exposing it freely to the electrolyte.

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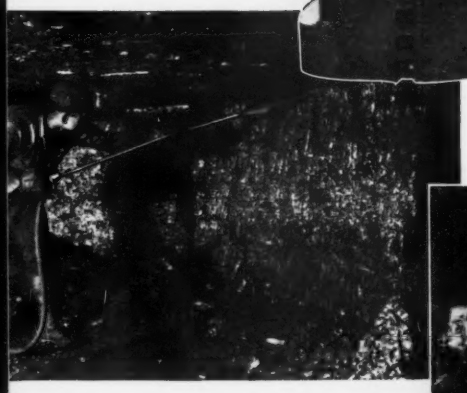
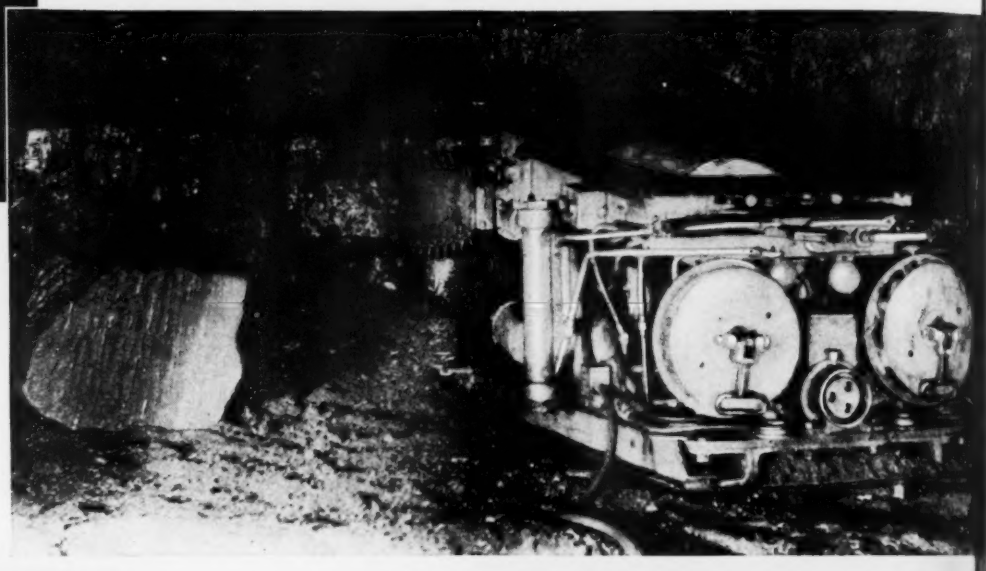
NEW METHODS . . . NEW MACHINES . . . FOR FACE PREPARATION

New Sullivan 7AU Coal Machine which can use either a standard kerf cutter bar or thin kerf saw. Exactly meets the requirements of many mining problems.

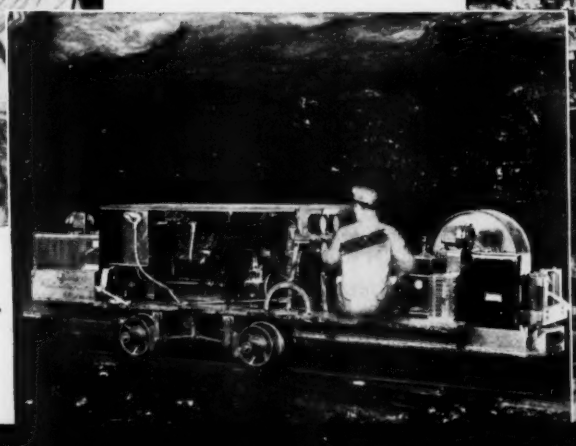




SAWED COAL Entire face from rib to rib and top to bottom is cut into large blocks with thin kerf saw blade and then broken down with hydraulic breaker pad. Firm premium coal results which is subject to minimum degradation in handling and shipping. Upper illustration shows use of breaker pad which eliminates need for explosives in sawed coal mining.

AIRDOX MINING

Sullivan Airdox, the non-explosive mining method, uses the heaving, pushing action of compressed air to break down coal and roll it out of the undercut face in large premium lump. Note in illustration at right advantages of Airdox controllable pressures. Lower hole still partly visible shows non-shattering snubbing shot at low pressure to be followed by higher pressure shot in hole above (cartridge in place).



Sullivan Airdox Compressor. Heart of the well known Sullivan system of non-explosive safety mining. Airdox cartridge shown above is not destroyed by use. →

HOW do *you* prepare the face? Should you be *sawing* coal? Should you be using *Airdox*, the sensational Sullivan non-explosive mining method? Can you afford to do without the speed of *Pulsing Power* coal cutting machines? This is the time to ask yourself these questions. Sullivan engineers have again broken through tradition with both new methods and new machines to put new profits into mining. No other organization can offer you so many different ways of face preparation. This means a Sullivan man can recommend just the method or equipment best suited to your conditions. It is just good business to check your methods against the many new means now available in Sullivan equipment. SULLIVAN MACHINERY COMPANY, 307 N. Michigan Avenue, Chicago, Illinois.

Sullivan 7AU Coal Machine is licensed under patents to E. C. Morgan. Pat. Nos.: 1,706,961; 1,706,962; 1,953,325; 1,707,132; 1,271,197; 1,953,326.

Sullivan CLE-6 Long Wall Coal Cutter working a six-foot cutter bar in anthracite up a maximum 40° pitch.

Sullivan CR-8, standard shortwall undercutter. Equipped with the new Sullivan Pulsing Power Feed that brings new speed and economy to the most widely used type of coal machine.

Premium coal means more profit per ton. A Sullivan Coal Saw and hydraulic breaker pads produced this premium coal to step up earnings.

Sullivan CR-8 and CR-10 Coal Cutters cut fast . . . and they move fast from face to face on the newly improved Sullivan truck.

SULLIVAN

COAL CUTTERS • AIRDOX • COAL SAWS

in the Coal business

Cleanliness is next to Godliness

Coal Cleaned by the

Chance Sand Flotation Process

has set new standards in coal cleanliness. In principle a float-and-sink apparatus, it cleans coal as large as 8″ with an efficiency not affected by the size, shape or feeding rate of coal. Simple and automatic in operation, its accuracy is independent of the human equation. The Chance Process is the only cleaning method that can operate through the whole range of commercial specific gravities. The gentleness of handling by the Chance Process is unequalled. Operators find that Chance coal cleaning does more for their coal than other cleaning methods and their Sales Departments capitalize the uniformity and the better than 99% purity of Chance Cone cleaned coal; "the only *exact* method."

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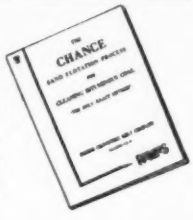
At Springfield, South Africa, we are building a 550-T.P.H. preparation plant to clean 9″ x ¾″ coal; our third preparation plant for the same operator.

At Zeigler, Illinois, the Bell and Zoller Coal and Mining Company's 1,000-T.P.H. preparation plant equipped with Chance Cones for cleaning 6″ x 5/16″ coal is approaching completion.

MATERIAL HANDLING
ROBINS
EQUIPMENT

The booklet "Chance Sand Flotation Process for Cleaning Bituminous Coal" is yours for the asking. Send for your copy.



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I would be pleased to have as checked:

Representative Call ☐ *"The Chance Sand Flotation Process" booklet* ☐
Bulletins on Equipment Items ☐

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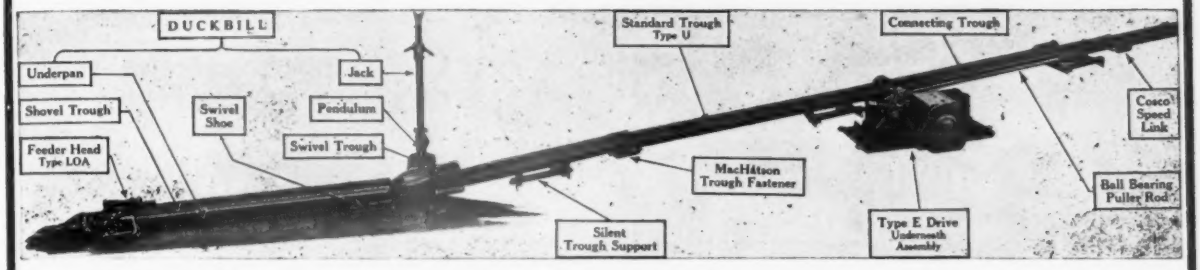
An Inexpensive Mechanical Loader

(Duckbill and Shaker Conveyor Combined)



Complete Goodman Shaker Conveyor Including Duckbill

A Type and Size for Every Need

Duckbill Feeder Head

The feeder head is the heart of the Duckbill and extends and withdraws the shovel unit. Operating levers are located on either side and are easy to operate. Safety release springs prevent damage should the shovel encounter the solid. Long life is assured by the use of a renewable manganese steel bottom plate. All parts are accessible from the outside making adjustment a matter of minutes. High and low types for all sizes of troughing are available. (Type LOA shown in illustration.)

Swivel Trough

This trough permits the Duckbill to operate through an arc of 60°. High sides and large overlap greatly reduce spillage. The pendulum, with its pipe jack, allows horizontal and vertical swing but prevents radial motion. Types to suit any size of trough.

Silent Trough Support

Goodman Silent Ball Bearing Roller Trough Support is truly quiet in operation. It is self aligning, has two trough heights and is anti-friction in operation. Since it is light in weight and is in two pieces, it may be easily handled. Lower frame may be inverted thus giving double life. This support is self-lubricating and fits any size trough.

Goodman Shaker Drives

Goodman builds seven types of drives ranging from 5 to 30 hp., open, enclosed or permissible electrical construction. Also a complete line of compressed air drives. All drives may be arranged for underneath, side or end connection. They have alloy steel gears which run in oil. All other moving parts are self-lubricating. Bar lugs on heavy steel skid plates make the drives easy to move. Ready access to all parts is accomplished by the removal of steel covers. Type E (The Goodman Little Giant) is shown in illustration. DID YOU SEE THE NEW REVERSIBLE DRIVE AT THE MINING CONGRESS? Inquire about it!

Ball Joint Puller Rod

Misalignment of trough and drive is sometimes unavoidable. The Goodman Ball Joint Puller Rod, in connection with a Goodman Double Swivel assures complete freedom of motion without strain to either drive or drive trough.

Additional Accessories

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Angle Troughs
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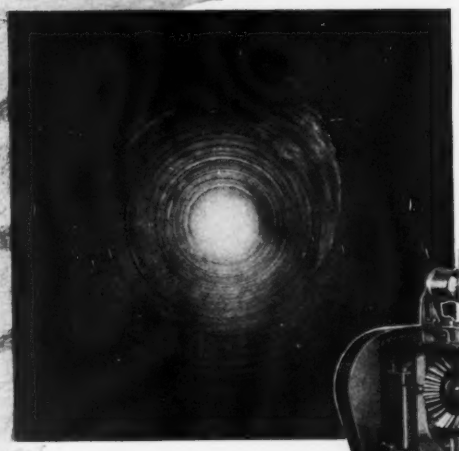
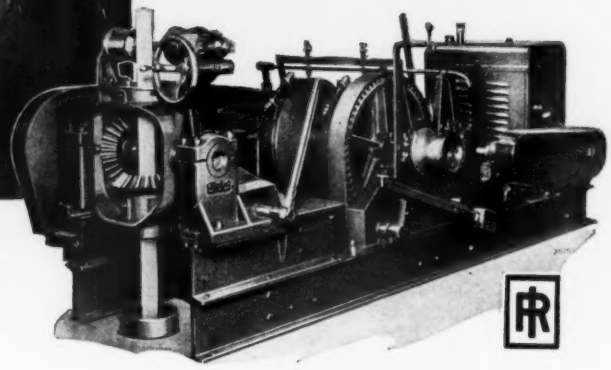
Good Ventilation TAKES the HEADACHES out of MINING . . . . Use CALYX CORE DRILLS





Above: View from the bottom of a 36-in. x 100-ft. hole used for ventilation and as an auxiliary man-way.

Right: Class "W" drill for tools up to 30 in. and with smaller tools for drilling to depth of 2500 ft. Gasoline, steam, or electric drive will be furnished.

Many "baffling" problems of mine ventilation can be successfully solved with "Calyx" drills. Time-tested and thoroughly proved in every respect, the "Calyx" method is today used extensively for drilling in every rock condition.

Machines are available in sizes for drilling holes from a few inches up to THREE FEET in diameter, and for depths to 2500 ft. or more. Units for drilling larger diameter holes can be furnished where conditions are suitable.

If your problem involves inter-connecting drainage or ventilation holes underground, or auxiliary holes from the surface, investigate the savings possible with efficient, economical "Calyx" Core Drilling. A well-illustrated, 48-page catalog describing these drills will be sent upon request.

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and uniform product

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Reversible, non-choking concaves are furnished as standard equipment except for small feed and fine product. A new type of dust seal positively prevents leakage of oil and prevents dust or water from entering the eccentric bearing.

This crusher unlike all others does not require an expensive permanent foundation. It is suspended from the plant structure by means of three cables that not only support the crusher, but also absorb the vibration and shock of crushing and prevent it from being transmitted to the supporting structure.

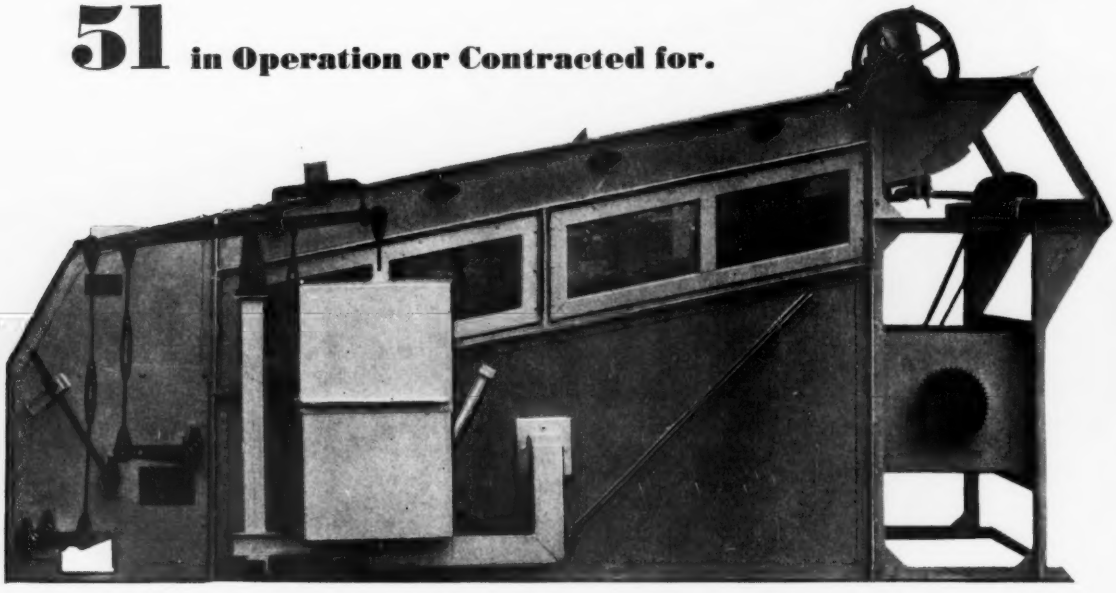
We would like to show you operating records of these modern crushers and how they have saved money in many crushing and mining plants. Get in touch with the nearest Allis-Chalmers office.

ALLIS-CHALMERS

— Allis-Chalmers Manufacturing Company, Milwaukee, Wisconsin, U.S.A. —

STUMP AIR-FLOW
combined Coal Cleaner and Deduster

51 in Operation or Contracted for.



Cleans only Sized Coals *from* 3″ To 0.

Especially adapted to 2″ slack. Dedusts while cleaning.

SPECIAL FEATURES:

No Reciprocating Table	No heavy vibrating parts No wear and tear on equipment and buiding Reduced maintenance
Low Power and Air Requirements	Because no heavy parts have to be vibrated
Side Windows	Which make the process visible at all times and enable adjustments to be made while machinery is in operation.

Our testing plant is equipped to handle car lot samples. Let us demonstrate on a commercial unit the cleaning possibilities of the Stump Air Flow on your coal. Write for test particulars.

If you desire to clean your coal using a wet process or a combination of both wet and dry our engineers are eager to help solve your problem.

Send for bulletins covering all phases of coal tipple preparation or cleaning which particularly interest you. No obligation to receive a call from our field representative. Our 34 years experience is yours for the asking.

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Defend The Constitution

IT IS NOT STRANGE that the anchor has ever been regarded as the emblem of faith. The drifting ship at sea was helpless without an anchor which could reach the placid waters far below the surface, and steady and hold the otherwise helpless vessel against the fury of the wind-lashed surface waters.

The anchor of our Government today, as always, is the Constitution. Thus far in history it has been a bulwark against the angry advocates of subversive doctrines.

The method of amendment is so tedious that full time is given for the cooling of the passion which, not so checked, might have wrecked our Government.

Whenever a popular demand spreads over the country which is in violation of constitutional principles, its effective execution has been halted by constitutional limitations. The more deliberate method of constitutional amendment and the time required for its accomplishment is our only safeguard against mob control. It is interesting to note that no amendment has ever been adopted changing our form of government.

Until now there has never been any serious threat of a change from representative government to a dictatorship. From the beginning of the present administration, there have been serious trends toward a complete breaking down of the framework of the National Government as composed of its three separate divisions, executive, legislative, and judicial.

The right of the executive to veto congressional acts, and the right of Congress, by a two-third majority, to over-ride the Presidential veto, indicates how largely the makers of the Constitution planned that representatives of the people should constitute the law-making power of the Government, in order that the will of the people, democracy, should prevail.

To the President was given the responsibility of enforcement of law, and to the Supreme Court the responsibility, under proper proceedings, to determine the constitutionality of the acts of Congress.

The rapid trend toward centralization of power in the Executive has been excused as a necessity to meet the needs of an alleged emergency.

Congress has largely abdicated its responsibility, and passed the acts prepared by the executive department without proper and frequently without any deliberate consideration.

It has, under orders from the Executive, made huge bankrupting appropriations to be expended by the executive department without limiting control. It has delegated its law-making authority to the President, to be by him delegated to such agencies as he might select, and this process proceeded without hindrance until something like 5,000 different individuals each had power to issue rules having the force of an act of Congress.

And then came the decision of the United States Supreme Court declaring illegal a large part of this democracy-devastating procedure. Autocratic governments have been created in the past either by the sword or by continual encroachments upon fundamental principles. The latter course was well under way when halted by the Supreme Court.

And now it is proposed to so amend the Federal Constitution that it will offer no bar to the solution of social problems by Federal authority.

As the writer sees the situation, any such proposal is dangerous at any time, and particularly so at the present time.

The need of constitutional restrictions increases in proportion to the gullability of the voting public. Will Rogers says: "It is not our public men that you can't put your finger on, its our public. We are the only fleas weighing over 100 pounds. We don't know what we want, but we are ready to bite somebody to get it."

A Congressman from an eastern district is commanded by 30,000 petitioners to support the Townsend Plan; Huey Long's "Share the Wealth Plan" can enlist the support of millions of voters; there is nothing but the Constitution to stop the more practical but not less dangerous "Share the Wealth Plan" now being executed by the Administration.

Two billion three hundred million dollars appropriated in 1934, four billion eight hundred million dollars in 1935, and in 1936, Presidential Year, it seems another doubling will be required to carry out the program.

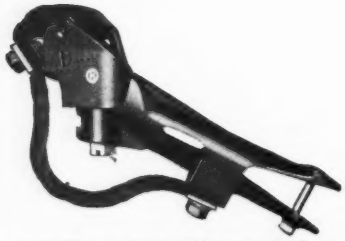
If we are to be a representative government, every representative of the people—Senator or Congressman—must act in behalf of the people whom he represents and resist and resent every coercive effort by the Executive. If we are to be a representative government, there can be no presidential "must" legislation.

Let us defend the Constitution against the onslaughts of the shiftless, the lazy, and the improvident; against political self-seekers and against those whose consideration of national affairs begins with 1929 and does not vision the previous 100 years during which this country grew from a third-class nation to the greatest nation in the world.

Let us protect and defend that Constitution under which we became the world's wealthiest nation, in which the highest wage levels, the highest standards of living, the most equitable distribution of wealth, and the greatest personal liberty is provided for every industrious, law-abiding citizen.

DEPENDABILITY PREFERRED

JUST as ocean voyagers have come to appreciate the dependability of modern liners, so too have mine operators discovered that the increased dependability of Ohio Brass locomotive equipment results in lower costs and greater profits. Ask the men who use O-B headlights, resistances, trolley wheels, and shoes why they are preferred. The answer is invariably the same: "Because they may be depended upon, day in and day out, to deliver maximum service at minimum cost."



O-B Heavy Duty Shoe and Harp

It is this heritage of unequaled dependability which has continued to inspire the men who design and manufacture this equipment. They are well aware of the fact that users have come to expect just a little bit more from materials trademarked with an O-B. And the desire to uphold such an enviable reputation is the best guarantee that this expectation will continue to be realized.

NRA U.S. CODE

O-B MS Headlight

1755M

OHIO BRASS COMPANY

Mansfield, Ohio, U. S. A.

Canadian Ohio Brass Co. Limited, Niagara Falls, Ontario, Canada

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The
MINING CONGRESS JOURNAL

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A Journal for the entire mining industry published by The American Mining Congress

The Tax Message

THE President's tax message threw consternation into industrial activity; it left Congress bewildered and uncertain. But it did more than these things. It clearly indicated the trend of the Administration's thinking (or strategy) and its ultimate purpose of "progressive taxation of wealth and income" to the end that wealth shall be redistributed. It expounded the age-old theory of achieving economic security through taking from those who have and giving to those who have not.

Wealth is capital, and capitalism is responsible for the remarkable advancement of our country. Whether wealth would be more efficiently handled by political agencies is certainly open to debate. The Government of these United States anticipates spending, within the next year, approximately $8,000,000,000. Part of this is for work relief, but a considerable portion is applied to actual Government expense. We have become so accustomed to loud-sounding figures that our sensibilities fail to grasp such sums as $8,000,000,000, but, whatever *our* deficiency, the money is raised through taxation. What of the agencies that are to spend this money collected by levies upon industry and wealth? Have we any reason to believe that political agencies are more competent than industrial leaders?

Large aggregations of capital have given us many things. For instance, a railroad system transporting us in comfort and safety at a ridiculously low cost; an automobile that has revolutionized American life; a telephone system of incomparable efficiency; great libraries, schools, and clinics, all of which have been a boon to the people.

It is a short-sighted policy that proposed to tax out of existence such benefactions: which seeks to take from the able and progressive to share with the improvident and shiftless. A Government founded upon such a fallacy is headed in the wrong direction. Political control of wealth, through taxation, offers no remedy in the present emergency. Wealth in the hands of industry has demonstrated its efficiency. Let us make haste slowly in any change.

Nationalizing Coal

ALTHOUGH certain sections of the coal industry are ready to contest the constitutionality of the Guffey-Snyder coal bill if it shall become a law, and although reputable authorities have declared that the proposed legislation is unquestionably unconstitutional, the United Mine Workers are pushing hard for its enactment. There is little doubt but that the strike threat is being used in the endeavor to hammer the bill through.

Public attention has been steadily focused upon bituminous coal for more than three years. Operators have been in almost constant conference in Washington. Hearings, code meetings, and wage negotiations have been numerous. The cost of all this to the industry has been tremendous, and so far little has been gained by the three active groups: the operators, the workers, and the Government.

Granting the complexities of the coal problem, and its conflicting inter-relations, including wage scales, freight differentials, and unfair competition, nationalization of the coal industry would be a national calamity. Particularly is that true if it means control of the industry by the United Mine Workers, with their demand for continuously higher wage scales and shorter hours. Whatever legislation finally is adopted should be well considered, and the industry not further harassed by unsound, uneconomic, not to mention unconstitutional experiments. Whatever is adopted in behalf of coal should be with an eye to the future and the best good of all interests involved, and not an expedient to bolster a labor union or any one section of the industry.

National Emergencies

WHEN the present administration took office it declared that a "national emergency" existed. On that principle it proposed legislation that has since been declared unconstitutional; it spent billions of the taxpayers' money; it started out upon a re-distribution of wealth, and the starting of the wheels of industry through a "priming of the pump" principle. Industry went along with all of these proposals in a remarkably docile manner. It accepted dictums and dictates from the political agencies, and adjusted itself to meet the strange new situation.

Did labor do likewise? If an emergency existed, did it apply to only a part of the people? Did such an emergency presuppose that the taxpayer and investor make all the sacrifice in the name of national recovery?

Labor's first organized act under the new deal was the ultimatum that all workers must join the union; it has consistently declared its "right to strike" against every tenet of the program with which it did not agree. Its attitude has not been one of cooperation with industry or government. Rather, it has assumed a belligerency that is directly opposed to the spirit of "meeting a national emergency."

The right of the individual to stop work is inherent in our freedom. No law ever could or ever should be advocated that would in any sense mitigate that right. But, if labor is sincere, it will voluntarily agree not to use the strike during the emergency and while thousands of men are unable to work no matter how great their desire. Labor paid an extreme price in the depression through the loss of jobs and reduction, if not complete abolishment, of its wages. It is not with labor that the fault is to be found, but with the ambitions of labor organizations to build up organization power.

Of all things . . .

ONE of those awkward facets of the New Deal that new dealers don't like to talk about was exposed to public gaze when the situation underlying the sudden shifts in the President's tax program came out in the open. . . . For once Democratic leaders took open Republican jeering quietly and sitting down. . . . They couldn't do anything else. . . . It was one of those cases of "The President right or wrong but wrong or right the President." . . .

■ ■ ■

The fine thing about it all was the loyal manner in which Senator Robinson, the majority leader, and Senator Harrison, chairman of the Finance Committee, quietly took the "fall," accepting blame for the shifts in the program. . . . Harrison first opposed taking up the tax program this session . . . a few days later for a reason best known to himself, he reversed himself, worked all night on a tax bill and made plans to attach it as an amendment to the pending nuisance tax resolution, then finally learned (from newspapermen) that the President disclaimed any intention of wanting to rush the tax program through as an amendment. . . .

■ ■ ■

Wonder if Senators Robinson and Harrison remember what former Senator James E. Watson, Republican Senate leader under Hoover, said?

"I want to stand behind the President (Hoover)," declared the Indianian on one occasion, "but he moves around so much that a man would have to have the St. Vitus' dance to do it."

■ ■ ■

The pros and cons over what ought to be done with the $250,000 willed to the United States by the late Supreme Court Justice Oliver Wendell Holmes are on the way to being resolved. . . . The money is to go into a trust fund to build up a collection of legal literature in the law department of the Library of Congress. . . . The House passed and sent to the Senate for concurrence a resolution providing for such action. . . . There are rumors that the President's suggestion settled the controversy which existed in Congress over what ought to be done with the money. . . .

■ ■ ■

Best laugh of the recent national Shrine convention in Washington. . . . A husky, genial Shriner, escorted to a gallery seat in the Senate while below him earnest and bitter debate over the utility holding company bill was going on, pulled off his red fez, waved it wildly and bellowed "Hello Jack." . . . He was addressing Vice President Garner who had just left his seat as presiding officer. . . . To a shocked attendant the Noble explained in a stage whisper . . . "We're friends. Heck, he waved to me at the parade last night. I guess I can wave back to him." . . .

A pretty kettle of fish is brewing over the Constitution of the United States. . . . This is above and beyond all the talk of amending the document. . . . Now and for a long time the original document has been housed in a glass case in the Library of Congress. . . . Finishing touches are now being put to the new $12,000,000 marble palace to be known as the National Archives building. . . . The question is whether the Constitution is to be moved to the new building. . . . Dr. Herbert Putnam says it will take an act of Congress to move the Constitution and the Declaration of Independence from his Library of Congress. . . . R. D. W. Connor, the new national archivest, admits it's a "ticklish question" but points to President Hoover's statement when the cornerstone of the new building was laid when he declared it was here that the most sacred documents of the Government would be kept. . . . Strangely enough, no Congressman has yet "introduced a bill" to settle the question.

■ ■ ■

It cost the taxpayers a pretty penny for Senator Huey Long's 15½-hour filibuster on the NRA extension resolution. . . . The Louisianian's remarks covered 83 pages of the Congressional Record. . . . It costs about $50 a page to print the Record, hence $4,150. . . . Not to speak of some 200 hours' lost sleep by three score Senators . . . and a lot of ruffled tempers that upset Congressional thinking for days thereafter. . . .

■ ■ ■

Fifteen men in Congress—four Senators and eleven Congressmen—are foreign born. . . . The Senators are Couzens and Murray, both born in Ontario, Canada; Wagner in Germany, and Davis in Wales. . . . The eleven Congressmen are Sabath (dean of the House), Czechoslovakia; Burnham, England; Crosser, Scotland; Stack, Ireland; Jacobsen and Schuetz, Germany; Cavicchia and Palmissano, Italy; Binderup, Denmark; Ellenbogen and Stefan, Austria.

■ ■ ■

The palatial $20,000,000 one-block square new Labor building is equipped with shower baths alongside the offices of chief administrative officers. . . . But there is much grumbling. . . . The builders forgot to put up clothes hooks in the shower rooms and no one wants to drive nails into the fancy walls. . . . Most of them hang their clothes on a chair in the office and dash into the shower room au naturel.

■ ■ ■

The Senate is funny only some of the time . . . the House is amusing most of the time. . . . For instance the House didn't spend its longest single session of this Congress in debating something like the four billion dollar works relief bill, or even such far-reaching and vital legislation as social security . . . its longest single session thus far was spent in debating a $20,000 annual appropriation measure for American participation in the Interparliamentary Union (an organization of nations to promote international arbitration).

Wheels of Government

THE Congress recovered slowly from the shock of the Supreme Court decision in the Schechter "sick chicken" case. Legislative activity slowed down very definitely in both Houses and effort was concentrated on "saving face" attempts to continue the NRA. H. J. Res. 295, extending NRA for two years was introduced by Chairman Doughton of the Committee on Ways and Means. This resolution provided an extension of the NIRA to June 16, 1937. It authorized and directed the President to approve or prescribe codes of fair competition. No code was to be established for any trade, industry or sub-division thereof not subject to the federal power to regulate interstate and foreign commerce. Price fixing by concerted action was forbidden with the exception of such provisions as the President should find necessary in the public interest, in order to prohibit discriminatory price cutting or otherwise to protect small enterprises against discrimination or depression or to deter the growth of monopolies or to prevent the waste of mineral resources; provided that no person shall thereby be prevented from selling goods or services, without discrimination between customers, at a fair competitive price. Codes were to contain provisions establishing minimum rates of pay, maximum hours of labor, the requirements of Section 7(a) and the prohibition of child labor. The Federal Trade Commission was to be authorized to issue cease and desist orders upon findings by the President that members of a code were engaging in unfair methods of competition. Provision was made for a fine of $500 for each offense, each day of violation of code provisions constituting a separate offense. The exercise of governmental authority in administration and enforcement of codes was to rest solely in public officers or agencies of the Federal Government. The President was to review for compliance with the requirements of the joint resolution every code in effect. Such codes were to continue for six months, but not thereafter unless the President had reviewed and approved them.

Extensive hearings were conducted on H. J. Res. 295 beginning May 20 and in the confused state of affairs brought about by the Schechter decision, the Committee on Ways and Means finally substituted S. J. Res. 113 (Clark, Dem., Missouri) which had passed the Senate and had been received by the Committee. As amended the resolution reads as follows:

"Joint Resolution.

"To extend until April 1, 1936, the provisions of Title I of the National Industrial Recovery Act, and for other purposes.

"Resolved by the Senate and House of Representatives of the United States of America in Congress assembled,

"That Section 2(c) of Title I of the National Industrial Recovery Act is amended by striking out 'at the expiration of two years after the date of enactment of this act' and inserting in lieu thereof 'on April 1, 1936.'

"Sec. 2. All the provisions of Title I of such Act delegating power to the president to approve or prescribe codes of fair competition, and providing for the enforcement of such codes are hereby repealed."

S. J. Res. 113 as amended passed House June 7. Now goes to Senate for concurrence. May not be necessary to send measure to conference. Early enactment anticipated.

The resolution was passed by the House of Representatives, June 7, and proceeded to the Senate where it was amended to read as follows:

[PUBLIC RESOLUTION—No. 26—74TH CONGRESS]

[S. J. Res. 113]

JOINT RESOLUTION

To extend until April 1, 1936, certain provisions of Title I of the National Industrial Recovery Act, and for other purposes.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That section 2 (c) of Title I of the National Industrial Recovery Act is amended by striking out "at the expiration of two years after the date of enactment of this Act" and inserting in lieu thereof "on April 1, 1936."

SEC. 2. All the provisions of Title I of such Act delegating power to the President to approve or prescribe codes of fair competition and providing for the enforcement of such codes are hereby repealed: *Provided,* That the exemption provided in section 5 of such title shall extend only to agreements and action thereunder (1) putting into effect the requirements of section 7 (a), including minimum wages, maximum hours, and prohibition of child labor; and (2) prohibiting unfair competitive practices which offend against existing law, including the antitrust laws, or which constitute unfair methods of competition under the Federal Trade Commission Act, as amended.

Approved, June 14, 1935.

S. J. Res. 113 to extend the NIRA was then returned to the House, where, on June 14 it was approved and sent to the President for approval. The announced plan of the administration for further NRA activity is that a skilled organization shall be maintained for the purpose of assembling information which will develop a comparison of the state of business in the nation under the NRA and under subsequent periods. It is planned that complete records shall be assembled by the NRA staff in the matter of the adherence of industry and of business enterprises to the wages, hours and child labor practices prevailing under the NRA and subsequent thereto.

The Lewis-Doughton Economic Security Act, H. R. 7260, was passed by the Senate on June 19. Included in the Act as it proceeded to conference, were two amendments of particular interest to mining enterprises; one by Senator Clark (Dem., Missouri) is designed to protect employers who desire to operate private annuity plans. The other, by Senator LaFollette, permits states (such as Wisconsin) to continue with individual industrial company unemployment insurance fund provisions.

The Public Utilities Act of 1935, known also as the "holding company bill" passed the Senate on June 11 carry-

(*Concluded on page* 66)

MINING EVENTS

Coal

THE coal industry, particularly the bituminous branch, has continued to spend the greater part of its time in Washington negotiating with the United Mine Workers of America for a new wage scale, and attending hearings on the Guffey-Snyder coal stabilization bill. Twice since May 15, the U. M. W. of A. have threatened strikes; the first was prevented through the intervention of the President of the United States, and the second by the Secretary of Labor, acting for the president. As the situation now stands the present working agreement remains in force to July 31, and all speed ahead is proposed for the passage of the Guffey bill. Hearings before the subcommittee of the House Ways and Means Committee were concluded late in June, and sentiment for and against the measure is still drastically divided in the industry. In spite of the excitement and concentration on the wage scale and legislation, the bituminous industry has managed to produce a substantial tonnage. According to the Bureau of Mines reports for the week ending June 22, approximately 4,785,000 net tons were produced. Production for the year to June 22 is 182,839,000 tons, or about 6,000,000 tons ahead of production for the same period in 1934.

Among operators appearing before the Ways and Means subcommittee considering the Guffey-Snyder bill were: Thomas Moses, president, H. C. Frick Coke Co.; J. W. Carter, representing the Smokeless Coal Operators; E. C. Mahan, president, Southern Coal & Coke Co.; Thurlow G. Essington, John L. Steinbugler, and H. L. Findlay, representing the National Conference of Bituminouus Coal Producers; E. R. Hawthorne, vice president, Pocahontas Fuel Co. and chairman, Committee Against the Guffey Bill; Charles O'Neill, appearing as chairman of the legislative committee of the National Conference of Bituminous Coal Producers; J. D. Francis, president, Island Creek Coal Company; Charles G. Berwind, vice president, Berwind-White Coal Mining Company; Chas. R. Holton, vice president, Bethlehem Mines Corporation.

ESTIMATED PRODUCTION OF ANTHRACITE (Net Tons)

	1935 Week	1935 Daily avg.	1934 Week	1934 Daily avg.
June 1	1,240,000	248,000	1,115,000	223,000
June 8	1,387,000	231,200	1,057,000	176,200
June 15	1,450,000	241,700	776,000	129,300
Cal. year to June 15, 1935	26,066,000		12,788,000	
Corresponding period, 1934	30,559,000		12,323,000	
	Decrease 4,493,000 tons, or 14.7 percent.		Increase 465,000 tons, or 3.8 percent.	

THE total production of anthracite (which includes colliery fuel) for the week ending June 15, as estimated by the United States Bureau of Mines, amounted to 1,450,000 net tons. This is an increase, as compared with production of the preceding week, of 63,000 net tons, or 4.5 percent. Production during the corresponding week in 1934 amounted to 776,000 tons.

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SUSPENSION OF ANNUAL ASSESSMENT WORK

A BILL providing for the suspension of annual assessment work on mining claims held by location in the United States.

That the provision of Section 2324 of the Revised Statutes of the United States, which requires on each mining claim located, and until a patent has been issued therefor, not less than $100 worth of labor to be performed or improvements aggregating such amount to be made each year, be, and the same is hereby suspended as to all mining claims in the United States during the year beginning at 12 o'clock m. July 1, 1934, and ending at 12 o'clock m. July 1, 1935: Provided, That the provisions of this act shall not apply in the case of any claimant not entitled to exemption from the payment of a Federal income tax for the taxable year 1934: Provided further, That every claimant of any such mining claim, in order to obtain the benefits of this act, shall file, or cause to be filed, in the office where the location notice or certificate is recorded, on or before 12 o'clock m. July 1, 1935, a notice of his desire to hold said mining claim under this act, which notice shall state that the claimant or claimants, were entitled to exemption from the payment of a Federal income tax for the taxable year 1934: And provided further, That such suspension of assessment work shall not apply to more than 6 lode-mining claims held by the same person, nor to more than 12 lode-mining claims held by the same partnership, association, or corporation: And provided further, That such suspension of assessment work shall not apply to more than 6 placer-mining claims not to exceed 120 acres (in all) held by the same person, nor to more than 12 placer-mining claims not to exceed 240 acres (in all) held by the same partnership, association, or corporation.

Passed—June 13, 1935.

★ ★ ★

Copper

THE copper industry has indicated its inclination to seek a voluntary agreement under the skeletonized NRA. It would be the first of the big industries to take such action. However, the industry is uncertain whether or not the terms of the new NRA Act are broad enough to allow it to draw an agreement which would be a complete substitute for the old code which governed price, production and sales allocation.

The industry's attitude was set forth in an announcement which read:

"The United States Copper Association, representing all of the producers and custom smelters of copper within the United States, met today and unanimously voted:

"1. That the Association should take up the functions of the former Code Authority in so far as liquidating all unfinished business of the Code Authority at the time it ceased to function;

"2. That the Association would, in so far as it might be advised it was legal and proper so to do, cooperate in maintaining the existing standards and practices;

"3. A committee was appointed to study and report to the Association the extent to which future cooperation is legal and proper."

Apparently the industry is confused and there is conflicting legal opinion as to how much cooperation it can continue without the legal power carried in the NRA code in force prior to the Supreme Court decision. Practically all copper men are agreed that continuance of sales allocation and price maintenance is necessary for the immediate welfare of the industry. A recent announcement indicates that the U. S. Copper Association, first formed in January, 1934, to facilitate code formulation, has been revived in hope that it can replace the liquidated code authority.

Some of the industry's lawyers believe that it is impossible to get confirmation of a voluntary agreement which includes production allocation or price fixing. Others hold that if it is all right for the President to approve a voluntary agreement it is all right for an industry to agree among themselves without going to the President.—*From The Wall Street Journal.*

E. A. HAMILTON

General Manager, U. S. Smelting Refining and Mining Co., Salt Lake City, Utah. Chairman, Board of Governors, Western Division of The American Mining Congress, which holds its annual meeting at the Palmer House, Chicago, Ill., Sept. 23-27, 1935.

The second point which the industry is considering is how far members can go in cooperation with each other without running afoul of the anti-trust laws. —From *The Wall Street Journal.*

THAT the amendment to Title 1 of the National Housing Act increasing bank loans for modernization from $2,000 to $50,000 under 20 percent Government guarantee will result in a market for many millions of pounds of copper and its alloys is the prediction of Bertram B. Caddle, secretary of the Copper & Brass Research Association of New York. Mr. Caddle expressed the belief that within the next 12 months the consumption of copper and its alloys in the building field may reach a total of more than 200,000,000 pounds.

"There has been a marked increase in the use of copper, brass and other copper alloys in the building field in the modernization of homes," Mr. Caddle says, "but that, in my opinion, is a relatively small tonnage as compared with the use of these metals as a result of raising the limit to $50,000. The reason for my optimism can perhaps best be outlined in four points:

"First: Until the amendment to Title 1 was passed, it was impossible for hotels to borrow sufficient money under Governmental guarantees to make necessary repairs. We have received many letters, as have our member companies, from hotels announcing their intention to replace rusted pipe with either copper or brass pipe or copper tubing. They also intend replacing wornout roofing materials with copper, and plan to use solid brass and bronze hardware and lighting fixtures.

"Second: Thousands of owners of apartments are going to take advantage of the amendment to make similar repairs. They appreciate the fact that it is much easier to rent up-to-date and modernized apartments that have free-flowing water from rustproof pipe and tubing, than it is to rent them if the water has a reddish color as a result of flowing through corroded pipes. Modern lighting fixtures and hardware add charm and a homey appearance to apartments.

"Third: Owners of multiple-family houses are going to take advantage of the liberal loans to improve their property for, like the apartment house owners, they realize it is much easier to rent their houses if they have been modernized.

"Fourth: Industry is going to spend millions to modernize mills and factories. By modernizing in this field, I mean to replace wornout plumbing with rustproof materials. I believe the activity in this field will be far greater than most anticipate for I recently visited factories of many diversified industries and have heard the owners and superintendents complain about leaky pipes."

Lead and Zinc

THE members of the Lead Industries Association have elected the following board of directors:

Clarence Glass of Anaconda Sales Company; B. N. Zimmer of the American Metal Company, Ltd.; F. H. Brownell of American Smelting & Refining Company; Stanly A. Easton, Bunker Hill & Sullivan Mining & Concentrating Company; E. A. Bendelari, president of Eagle Picher Lead Company; Ivan Reitler of the Federated Metals Corporation; James F. McCarthy, Hecla Mining Company; T. E. Sprague, Metals Refining Company; F. M. Carter, president of National Lead Company; George W. Lambourne, Park Utah Consolidated Mines Company; W. Y. C. Hunt, Reynolds Metals Company; Clinton H. Crane, president, St. Joseph Lead Company; W. Mont Ferry, Silver King Coalition Mines Company; J. W. Wade, Tintic Standard Mining Company and F. Y. Robertson of the U. S. Smelting, Refining & Mining Company.

The directors reelected the following officers: Clinton H. Crane, president; F. H. Brownell, vice president; Fred M. Carter, vice president, and F. E. Wormser, secretary-treasurer.

The Economy Slant on

MINE LOCOMOTIVES

By JOHN S. BELTZ*

OBSOLESCENCE, that yardstick of machine-use economy which was all but eliminated as a gauge of good plant management during depression days, is fast coming back into practice.

Of the several definite factors considered to determine when a particular machine should be replaced, the all-important item is whether the advantages of the new unit would warrant the replacement, by guaranteeing sufficient operating and maintenance savings along with equal or better performance in comparison to the old machine. A factor related to this is the time element—how long will it take to pay for the new machine out of savings?

A major saving to be expected from late designs is the greatly reduced maintenance costs per ton-mile. Besides, they offer several hidden or indirect savings. One is the result of more continuous operation with consequent reductions in time out. Another is contained in the greater speed of new main line locomotives which contributes to higher output on the man-hour crew basis. The total amount that can be saved in these ways depends of course upon the age and condition of the existing units, whether their speed and draw-bar pull characteristics are suitable for the haul, whether the haul is getting longer from year to year, or whether the mine is on the retreat and the haul is getting shorter.

I feel safe in saying that in certain extreme cases the savings made by a new locomotive will return the investment in two to three years of good running time. In other cases it might take as much as five to six years.

When it comes to the possibility of savings other than those resulting from lower maintenance cost, intelligent matching of the locomotive to the duty or conditions is the all-deciding factor. Over the years operating conditions in general have been radically changed. Therefore old-time locomotives once well-suited to conditions encountered frequently are found to be no longer adequate, even though they may be maintained about as efficient as ever. On top of this, methods and layouts have been altered. The demand for greater precision in both the completion and coordination of the various phases of operation lays increasing emphasis on timing. Delays, consequently, are costly—especially those in haulage—inasmuch as they affect the other and interdependent operations—from the source, back to the face, and out to the mine mouth, preparation plant and railroad car. Furthermore, newer methods are more largely based on hourly rather than tonnage terms of wages, so that the company and not the worker is penalized.

Mines are bigger. The main hauls have become longer and trip schedules speeded up. Multiple-shifting is becoming more a practice. Used under these circumstances, old locomotives show a high maintenance cost per ton-mile. Furthermore, their ton-miles output per man-hour of locomotive crew is much lower than it would be for a properly fitted modern locomotive under the same conditions.

In the matter of maintenance, there are good reasons why the mentioned differences exist. The typical locomotive of 1910 or earlier had cast iron side frames and bush bearing on the armature shafts. Journal boxes were all of the plain bearing type, many of them taking the wheel thrust on the wheel hub and axle linings or suspension. Bearings were all brass. Little thought was given to sealing them off to keep out dust coming from the brake shoes or elsewhere. Controllers were of the drum type, often too small according to today's standards for the work expected.

In contrast, the modern haulage locomotive of this day has ball or roller bearings on the motor suspension and journal boxes, and the boxes are larger to accomodate these bearings. This permits the use of larger and more flexible springs. The entire assembly is equalized and thus easier on the track, at the same time giving better riding qualities. Cast iron side frames have been replaced by rolled steel slabs. The small drum controller has given way to larger drums, with the main brake being taken by contactors or by contactor control. The sanding mechanism has been improved, and the old iron ribbon or grid resistance has been replaced by some form of continuous steel strip resistance.

On gathering locomotives improvements have been made in reels, journal boxes, and suspension bearings. Greater stiffness and rigidity have been imparted to the frames and extra space has been provided for trip rider and motorman. On many old gatherings locomotives the trip rider had to hang to the end of the bumper where he was in constant danger of injury. Today mine management would not think of buying a gathering locomotive with no seating space for the trip rider. Further, for gathering service, slow speed locomotives are now the accepted standard, and gathering zones have been contracted. As against this, years ago gathering locomotives usually hauled their trips a considerable distance; and so they were in fact secondary haulage as well as gathering units. In general, the many advantages offered by slow speed locomotives in gathering service have been so widely recognized that hundreds of older units have been rebuilt to reduce the speed from six miles an hour to only four. But not all of the other out-of-date features have been corrected.

Compared to most unit machines, the locomotive offers wider possibilities for rebuilding old units in accordance with modern standards, owing to its greater simplicity of design. But the extent to which this can be done or is profitable can be strictly judged only by weighing the pros and cons in each particular case. It should be carefully ascertained, before any other step is taken, whether the locomotive under consideration will have, when rebuilt, the characteristics for duty on some specific haul where a unit is needed. To illustrate this point, consider the 4-ton gathering locomotive, whose usefulness is rapidly drawing to an end. The tendency in recent years has been toward larger mine cars which increase the loading on gathering equipment originally installed to handle smaller cars. For this new duty 4-ton locomotives, of which an appreciable number are still in service, are undoubtedly too light, both as to weight and motor equipment. High maintenance expense results, and in every such case it would be economical to declare the equipment obsolescent and replace it with heavier locomotives incorporating all recent improvements in design. Today the gathering locomotives accepted in best practice are of the 6- and 8-ton type.

As applied to mine locomotives, governing factors tempt a more liberal and sometimes a very loose meaning to the

* Chief Engineer, Mining Division, Jeffrey Manufacturing Company.

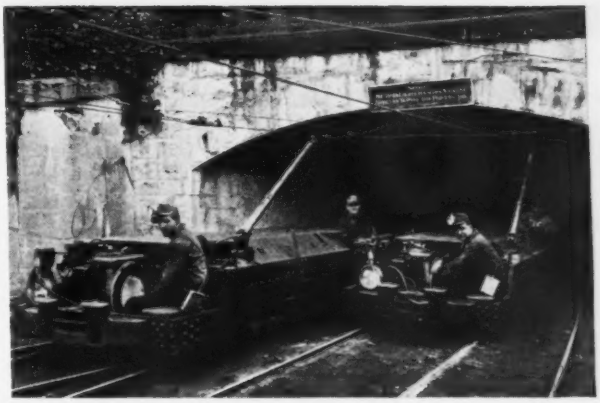
term obsolescence. Obviously, unless a fund is established and earmarked by depreciation accounting, to take care of replacement of the equipment covered when the need occurs, then obsolescence is not used as the powerful profit-making tool that it is; and its meaning in practice changes into an index of the age, condition or relative utility of the apparatus.

Good reason in many cases can be advanced for failure to adhere to this sound investment regulation. For several years, until recently, profits from coal mining have been generally scarce. So many mine owners have been unable or not inclined to add much to capital account for improvements. They chose or were forced to the alternative of increasing maintenance expense of plant or equipment either for keeping it *status quo* or for rebuilding it in part. Certainly this procedure is better than letting operation facilities run down. It does bring about improvement. But the fact nevertheless remains that in many cases if more dollars were spent on complete unit replacement, each dollar would return a higher profit. There is a limit to the economy of maintaining old equipment.

Only in the degree that modern design can be matched or approached will the rebuilding process yield a job requiring comparable low maintenance attention. Since improved details of locomotive design have been attained progressively over the years, it follows logically that the older the locomotive, the more difficult or the more expensive it is to bring that unit within the sphere of modern design by rebuilding. If the side frames have been buckled or cracked, armatures and gears need replacement, wheels and axles and journals are badly worn and controllers punctured and burned—then there is little left for salvage and use as the foundation for rebuilding. Certainly if the locomotive is of the age when cast iron side frames were used, it should be scrapped without further ado.

It is pretty difficult, if not impossible, to generalize on the matter of modernizing locomotives that have been in service for more or less long periods. Conditions at various mines are different; shop facilities are not alike; and the talent and ingenuity exhibited in workmanship vary. Furthermore the problems of revamping gathering locomotives and haulage units are different, as the specifications of these two types diverge so greatly. What has been said is not, however, intended to discourage rebuilding. This frank discussion is aimed to sound cautions against imprudent hope for achievement that cannot be realized and to set forth the approximate limitations. If the locomotive under question has a fitting place in the mine and is susceptible to satisfactory modernization at not too great cost, rebuilding may be a wise decision. The truth is that there are many gathering and also haulage locomotives that can be profitably improved by incorporation of the newest features.

Often controllers of increased capacity can be installed with main line contactors on all locomotives or with semi-magnetic contactor control on haulage locomotives. The improved continuous steel strip resistance can be utilized to replace the old cast-iron grid resistance whose weakness lay in its tendency to break or to create high resistance points at grid terminals when the retaining bolts loosen. Anti-friction bearings can be installed in some instances, depending upon the type of motor, space available, etc. Their installation on the armature is in most cases simple. To motor axle suspension the application is somewhat more complicated but feasible if the motors are still in standard production. The fitting of anti-friction bearings to the journals is possible with some changes, usually in the frame. Sometimes an anti-friction journal box can be placed in the space provided for the plain bearing journal box.



Two 8-ton Gathering Locomotives of Explosion-Tested Design

A 25-ton Haulage Locomotive with Semi-Magnetic Control

Haulage locomotives initially purchased for comparatively short hauls, but now operating on longer hauls, due to extension of the mine, can be improved so far as maintenance is concerned by the before mentioned modernizing devices. If the motors are running temperatures so high as to cause electrical troubles, maintenance requirements can be reduced by the addition of blower equipment. Frequently under the circumstances above delineated, however, the haulage equipment is not heavy enough for present duty. In that event it is economically desirable to relegate this main line haulage equipment to secondary haulage, putting new heavier equipment on the primary tracks.

A concrete example of substantial savings in maintenance from an investment in new locomotive equipment is presented by the experience of a certain large coal company at a mine in West Virginia. Six years ago, along with other haulage improvements, the company installed two 40-ton tandem units, replacing a number of 10-ton locomotives. Specifications covering them included every feature known to reduce maintenance cost. To date, they have hauled about 3,500,000 tons of coal at a total maintenance cost of ½-cent per ton, or one-third the maintenance cost of the replaced 10-ton units. This saving in maintenance cost alone has totalled over $30,000 in the six years.

This mine had had a high haulage cost per ton because of the number of locomotives required and because of the maintenance cost of these. The new locomotives have been performing economically because, among other things contributing to minimum maintenance, their motors and control equipment is of liberal capacity and not overloaded. Furthermore, the locomotives are of high speed so that more coal can be hauled in a given time by each unit and crew.

J. F. McCARTHY, president of the Hecla Mining Co., Wallace, Idaho, has given to the Montana School of Mines a fine picture of Marcus Daly, who made mining history in Butte. The picture had hung for many years in the office of the Hecla Mining Co. It now hangs in the office of Francis A. Thompson, president of the Montana School of Mines, and faces a bust of Senator W. A. Clark, which is interesting in view of the titanic mining battles between them. Those mining battles in Butte used to shake the state of Montana, and the reverberations registered sharply on the sensitive ears of Wall Street.—*Skilling's Review.*

Underground CONVEYOR Equipment

By **M. J. ANDRADA***

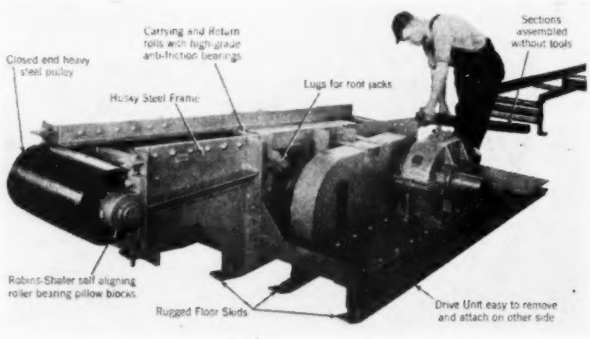
A GREAT deal has been written recently with regard to the application of conveyors for underground mine haulage, which clearly indicates the increasing interest in this subject on the part of the operators. The natural result is to attract a more concentrated study by the conveyor manufacturer to the field.

Today, we are confronted with two major conditions which open up further possibilities for conveyor mining. First, many of the easily worked rich veins have been worked out and, second, the operator is confronted with wage-scale demands which compel him to consider more economical methods of operation, in order that they can be met.

In our review of the numerous articles written on the subject, as well as the survey of the actual operating conditions, we have found the room and pillar method to be the most prevalent for conveyor mining. From the entry slopes, headings are driven at right-angles at the various seam levels and rooms cut on either side of the headings. The rooms vary from 40 to 60 ft. in width and from 300 to 1,200 ft. in length. The coal is hand-loaded on to a chain type face conveyor and slate and rock-gobbed back. The face conveyor delivers on to either a chain or belt or shaking type room conveyor operating at right-angles to the face from which it is delivered to mother conveyors, and thence to the car haulage system.

The most advanced development of equipment has not been created by the manufacturer alone, but by his cooperation with the user. As to the choice between chain and belt type room conveyors, there appears to be two schools among the operators, one who says, "The room conveyor is so close to the face operation that there is danger of destroying the belt when shooting," and the other who does not consider this a serious hazard. In our survey, we have found no serious casualties with either type.

For slope haulage, within the operating range of inclination of the belt conveyor, there is no question with regard to its efficiency and economy. There is, however, a very important consideration to be given to car haulage. In most cases, conveyors are being considered for existing mines that are already equipped with a car haulage system. It then becomes a question of how much capital can be written off against the contemplated saving. Furthermore, in considering the application of advanced methods of existing operations the first step is to apply the same where the greatest savings can be obtained. The gangways are already driven and are of suitable height for the operation of cars.


Closed end heavy steel pulley
Carrying and Return rolls with high-grade anti-friction bearings
Sections assembled without tools
Husky Steel Frame
Lugs for roof jacks
Robins-Shafer self aligning roller bearing pillow blocks
Rugged Floor Skids
Drive Unit easy to remove and attach on other side

Robins Conveying Belt Company Head Section and Drive Unit with Reversible Tandem Drive

This is not true, however, of room and room headings, as they are continually progressing and form a greater part of the overall operation. In the case of low seam work, the mining costs are greatly reduced, by the use of conveyors as it is not necessary to remove any of the roof or floor to provide haulage head room. In addition, in either low or deep seam work, there is a decided saving in transportation costs.

Let it not be misconstrued from the foregoing that conveyor operation is restricted to room and pillar method of mining. It is equally adaptable to long wall work, and there are many conveyor installations of this type in which the operators are obtaining very high coal recovery at great saving.

It is not the writer's intention to prescribe the correct method of conveyor mining, but to accept the methods established by the mining engineers and endeavor to adapt the most suitable type of conveying machinery to them. In this respect, the equipment falls under five general headings: Face conveyors, room conveyors, long wall conveyors, mother or collecting conveyors and entry or slope conveyors. They are all of the same general character, differing only in type and detail to suit their particular purpose.

For transferring or lifting material within the range of operation of the belt conveyor, it requires less power than other types and the power requirement is uniform. Thus, savings are effected in power, wiring and demand charges.

Each of the several units consist primarily of a drive unit, head section, intermediate sections and tail section.

The head section should be a compact, rugged unit providing suitable overhang for either delivering to cars or transferring to another conveyor. The drive unit should be a self-contained, separate unit, mounting the drive transmissions and motor, and designed so that it may be set on either side of the head section.

The head section illustrated is typical for mother and slope conveyors over 300 ft. long. For mine conveyors less than 300 ft. long, single drive head pulley should be used. For room conveyors which rarely exceed 400 ft., the single head pulley drive is adequate. The general appearance of the section is the same but a long takeup is provided within the frame which provides belt storage and permits extending the tail section as face cutting progresses without having to splice in short belt sections.

The intermediate section should be extremely low and of simple construction. The parts should be readily assembled and disassembled without the use of tools, should be sufficiently light to be handled by one man, but of ample strength to withstand the abuse of frequent handling in the mine. They should be rigid in the lateral direction so as to maintain conveyor alignment, but should provide flexibility in the vertical direction so as to conform with the irregularities of the mine floor.

The tail section should be extremely compact to facilitate receiving material from another conveyor without requiring excessive head room and should be well guarded to prevent "fines" getting in around the tail pulley. Slidable connection to the main conveyor frame and turnbuckle or screw jack connection should be provided so that correct tension can be maintained in the belt.

The conveyors are built in both the flat and troughed belt types. The room conveyors are generally flat type, the mother conveyors either flat or troughed, depending upon local conditions, and the slope conveyor is generally troughed.

* Consulting Engineer, Robins Conveying Belt Company.

Proper Lubrication and Maintenance of ROCK DRILLS

By B. C. ESSIG*

THE proper lubrication and maintenance of rock drills is of vital interest to every mining executive who desires to secure the most efficient operation at lowest cost. Nobody gains—and everybody loses—when rock drills must spend protracted periods in the hands of the "drill doctor" because lubrication and maintenance were not properly attended to. For when a rock drill breaks down on the job, the results invariably show up in costly time losses, in reductions of daily progress, and in actual money expended.

The first essential of rock drill lubrication is that it be thorough and continuous. Like every other mechanism which has moving parts, the rock drill must be completely lubricated at every point where friction is likely to occur. Such lubrication cannot be intermittent or haphazard. The penalty for negligence, carelessness or forgetfulness in this respect is swift and sure.

Wasteful and Ineffective Methods

Most manufacturers of pneumatic tools have made provision for lubrication by incorporating integral oil reservoirs in the tools. Nevertheless, operators have found it difficult to see that these reservoirs are kept filled. As a consequence, one frequently sees rock drills being lubricated by pouring oil in the air hose—a method which is not only wasteful but ineffective.

Need for "Trouble-Proof" Lubrication

A prime requisite in the lubrication of rock drills is that the lubrication system be as "trouble-proof" as possible. This means that rock drill lubrication must not only be simple and easy, but that it must be accomplished with little effort on the part of the operator. In addition, the lubrication system should be so designed that it is thorough, conserves lubricant instead of wasting it, and brings about uniform operation through uniform lubrication.

These elements of desirability in rock drill lubrication formed the basis of the problem which Gardner-Denver engineers considered in designing a line oiler which would be both simple and automatic in action. When the rock drill is in operation, the oiler supplies an ample quantity of finely atomized oil for all moving parts. The only attention required from the operator is filling at the beginning of each shift. When the drill is shut off, the flow of oil also stops, and oil does not siphon into the line. The oiler is attached to the hose about 10 or 12 ft. from the drill, a minimum distance of 10 ft. being specified so that the atomized oil can reach the drill and lubricate every moving part.

Selecting the Proper Lubricant

The effectiveness of any rock drill lubrication system is greatly enhanced by the use of the proper oil. Cheap oils do not pay, and the selection of a high-grade oil is always worthwhile from the standpoint of increasing efficiency and reducing repair and replacement costs. In general, the oil chosen should be a high-grade mineral oil which will pull readily at the temperature at which the drills are operating. Under no circumstances should rock drills be lubricated with machine oil.

Water, of course, destroys lubrication effectiveness. When you observe fogging at the exhaust parts, there is water in the cylinder, and this, in turn, usually means that the water-tube rubber needs to be replaced. On the other hand, when fogging occurs at the chuck end, it indicates that the water tube has been cut off.

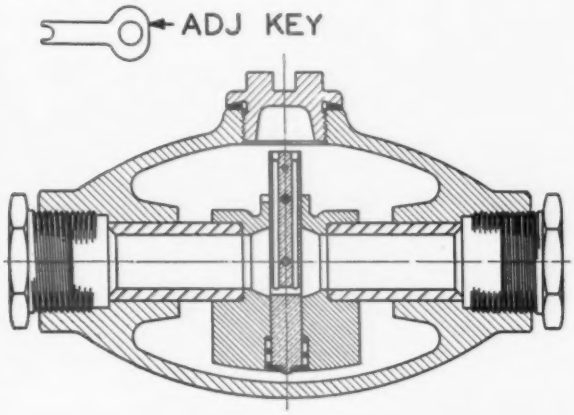
Reducing Maintenance Costs

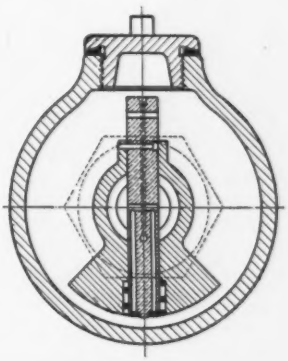
One of the principal causes of high maintenance costs in rock drills is the breakage of piston hammers. The causes of piston hammer breakage are usually poor shanks, worn chucks, or worn cylinder bushings. Make sure that your shanks are quenched in oil and are not too hard. A good test to determine the hardness of a shank is to cut it with a mill file. If the shank can be cut without rasping, it is not too hard.

Keeping chuck wear within the proper limits is essential in maintaining the required alignment between the drill steel and the piston hammer. When chucks become worn, crowned shanks usually follow, thus promoting rapid cupping of the piston hammer ends. Another frequent cause of loss of drill efficiency is excessive clearance between the piston hammer neck and the cylinder bushing. When this clearance is too large, the result is breakage, weak rotation and a decrease in drilling speed.

Maintaining Proper Air Pressure

A frequent cause of reduced air pressure is air pipe lines of insufficient size and air hoses which are too long. Sufficient air pressure may be maintained at the compressor, but if the hose is too long or too small, the pressure delivered to the drills will be relatively low. Friction within the hose also cuts down pressure and, although friction is always present, even in the best new air hose, this friction increases as the interior of the hose becomes worn. It is therefore desirable to test hoses at specified intervals to make sure that friction loss within them is not excessive.





* Gardner-Denver Co.

FAN Specification Suggestions

By W. J. MONTGOMERY*

IT MAY possibly surprise many operators to learn that for every ton of coal hauled from the average mine more than three tons of air are pumped into it by the fan. Thus a mine with a daily capacity of 3,000 tons will require about 200,000 cu. ft. of air per minute, usually continuously through 24 hours of the day. The approximate weight of air per cubic foot being 0.075 lb. ($0.075 \times 200{,}000 \times 60 \times 24 = 21{,}600{,}000$ lbs.), 10,800 tons of air will be delivered to the mine as compared to 3,000 tons of coal taken from it. At many mines, in consequence, the power cost of operating the fan far exceeds the total of power costs for all other machinery inside and out. In view of these facts, inefficiency in any considerable degree is accompanied by great loss—loss which can easily be corrected and converted to profit by stricter adherence to ventilation fundamentals.

This article is limited to a few of the points on which there should be a mutual understanding between operator and fan manufacturer, as a preliminary to specifications for a new fan. It includes a general form of inquiry which, if followed, will avoid much of the confusion that occurs today.

To have an efficient fan, the air must be gotten into and out of it with the least shock possible. One obstacle to the accomplishment of this is that the intake area is usually more or less obstructed by the bearings and their supports. The stream of air, furthermore, is greatly contracted in passing through the fan inlets, added to which is the fact that it necessarily makes a right angle turn into the wheel. Yet high velocities must be avoided at the intake. This is best achieved by making the area of the fan inlet equal to twice the equivalent orifice of the mine.

The equivalent orifice is merely another way of expressing mine resistance. As a resistance equivalent, it is seldom used in fan specifications because the resistance is much more conveniently expressed in terms of inches of water gage. Defined, the equivalent orifice is the area of a circular opening in a thin plate which offers a resistance equal to the mine resistance when passing a volume of air equal to the mine volume.

Getting back to the fan, its discharge plays an important part in fixing its efficiency. Though well proportioned for the actual duty to be performed, an exhaust fan will not operate at its maximum attainable mechanical efficiency if it is provided with an improperly designed evaseé chimney. In testing this type of fan, there is no great chance for error in taking the pressure readings. A hose or pipe inserted in the drifts, so long as it does not face the air velocity, will record the actual pressure produced by the fan.

A blowing fan must have a correct expansion from the casing to convert the velocity pressure into static. But even if this fan has a correctly designed discharge, it may be made to appear quite inefficient mechanically by the error of not giving it credit for the actual work done.

If the fan be of the straight blowing type, then a properly expanding discharge should be added to the end of the fan casing constructed in steel or masonry work. If this design is left up to the mine owner the chances are that instead of a slowly expanding discharge, the air will be emptied almost directly into a pool in the mine entrance and thereby cause all kinds of eddies. Of course, there will be some conversion effect with this disposition, but the conversion will be as nothing compared to that attained by a slowing down of the air within an angular expansion of not greater than 7 degrees.

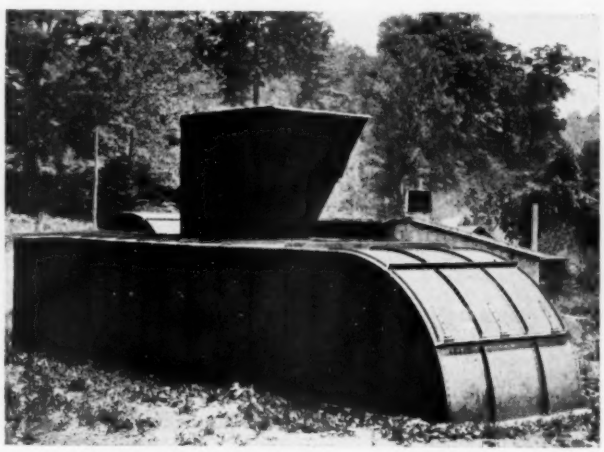
A blowing fan should be set back from the air shaft or drift opening a distance sufficient to allow the air in leaving the fan discharge to be slowed down to a velocity equal to that of its entrance to the mine drift or air shaft. Supposing the opening to the mine is 10 by 10 ft., or 100 sq. ft., and the fan discharge area is 25 sq. ft., and a volume of 100,000 cu. ft. is to be delivered. The distance which the fan must set from the mine, allowing for a 7-degree expansion on all four sides, can be solved by trigonometry, using the tangent 7 degrees, or 0.1228. The tangent of an angle equals the perpendicular side over its base. Since each side of the duct must expand 30 in., then

$$\text{Tan. } 7^\circ = \frac{30}{X} \text{ or } X = \frac{30}{0.1228} = 244 \text{ in.}$$

This indicates that the fan discharge should be located 20 ft. 4 in. from the mine entrance to give the best results.

The same results may be obtained by using a protractor and laying out this gradual expansion on a drawing board and measuring the distance. Draw a base line, set the protractor at 7 degrees and construct the hypotenuse of a right angle triangle. This hypotenuse should be extended to a point where a line drawn perpendicular to the base is 2 ft. 6 in. long. Then measure the base line or the adjacent side of the right angle triangle. Its length will be the distance the fan discharge should be placed from the mine entrance for the most efficient operation.

The exhaust fan presents a different proposition to the manufacturer. The air is discharged vertically, or at least it should be, so it might require a high chimney to comply with the best practice of the 7-degree angle of expansion. In some cases it would be advantageous to construct a horizontal chimney on the ground and, after expanding to the correct area for discharge, turn it up vertically with a good radius. This type of chimney might be made of concrete or of fabricated steel. It is rather expensive to construct a vertical chimney of



A Modern All-Steel, Fireproof Fan Installation

* Manager, Ventilation Division, Jeffrey Manufacturing Company.

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sufficient height and furthermore, unwillingness to pay the extra cost often precludes this best practice.

Why is it necessary to have a chimney with a high expansion discharge? In answer to this, let it be assumed that the air has a velocity of 1,414 ft. per minute in the drifts approaching the fan inlets, which is equivalent to ⅛ in. water gage velocity pressure; further assume that the total pressure measured on the exhaust side is 2⅛ in. and that a volume of 200,000 cu. ft. is being delivered by the fan. Now suppose a short chimney is constructed containing only 50 sq. ft. of area at the discharge. This would cause a velocity of 4,000 ft. or a velocity pressure of 1 in. water gage. As the fan has already been given credit for ⅛ in. of this pressure in the total measurement of 2⅛ in. in the drifts, the net loss in the chimney is ⅞ in. water gage or about 41 percent of the total gage in the fan drifts. This of course, would require 41 percent more power and make the fan very inefficient mechanically.

Now suppose the fan discharge is gradually expanded with a perfect conversion until a discharge area is reached where the velocity is only 1,414 ft. per minute. In this case there will be no loss from velocity so long as the fan is given credit for the ⅛-in. velocity pressure in the fan drifts.

The above example is a simple and valuable lesson in mine ventilation economy. The ⅞-in. pressure loss resulting from improper discharge would be transferred to the suction side of the fan if the chimney were properly designed. Then this pressure would be effective in producing mine ventilation instead of being wasted in expelling the air into the open atmosphere at a high velocity. When the chimney velocity pressure is transferred to the exhaust side of the fan, the total pressure produced would be 3-in. gage, and consequently would be instrumental in the delivery of a larger volume. If the additional air were not required, the speed of the fan could then be reduced to requirements, and thereby a great economy would be effected.

Of special interest is a comparison of the power required for the fan at its original speed with that required at reduced speed in the above example. A volume of 200,000 cu. ft. at 3 in. (2⅛ in. +⅞ in. chimney loss=3 in.), equals 94.5 air horsepower. If an overall efficiency of 60 percent is assumed for the fan, motor and drive, it will indicate a power consumption of 157.5 hp. If the speed of the fan is now reduced it will deliver the same volume with a total of 2⅛-in. water gage, which is equal to 67 air horsepower. Assuming again the same overall efficiency, namely, 60 percent, then the same effective work will be done on the mine with 111.7 hp., or a saving of 45.3 hp., when the fan is provided with a properly designed discharge. If this power saving is figured at only 1 cent per kw.h. for one year of continuous operation, it means a saving of $2,908. A properly designed discharge for the fan would cost not more than half the savings made in one year's operation. Therefore the added expense certainly would be justified.

It is recognized, of course, that discharge losses cannot be entirely eliminated. But proper designs accompanied by necessary expenditures will represent a long step toward their elimination. Let the air into the fan and out of it with the least possible amount of shock. A fan without this feature of design, though cheaper than with it, will turn out to be the more expensive in operation.

The fan manufacturer frequently is furnished data that is too meager to enable him to quote intelligently on a fan. Both the purchaser and the manufacturer ought to cooperate to the fullest extent in order that the fan purchased will be the one best adapted to ventilate the mine under consideration. Too often, the mine operator thinks that all he needs is a larger fan to give ample ventilation, whereas what he more frequently needs is more airway capacity.

The operator should be careful in specifying the existing mine resistance or water gage and the volume required. If the installed fan is operating against 3 or 4 ins. of water gage, probably a new fan will not be required as far as an increase of volume is concerned. That gage would indicate that more airway capacity is quite necessary. If the existing fan be of the modern type and not working above its normal rated capacity, it would be futile to install a fan of greater diameter expecting to get an increase of volume. Further, if a larger fan were installed it would operate at lower mechanical efficiency without any increase in volume. The purchaser, of course, should specify the volume of air required and at the same time be sure that the mine will pass this volume with the pressure specified in the inquiry. The following applies more specifically to centrifugal fans:

1. Specify the volume in cubic feet per minute.

2. Specify the pressure in inches of water gage.

3. Advise whether the fan is to be used as a blowing, exhaust or reversible type; and if reversible, will the main duty be blowing or exhausting.

4. Designate whether the fan will be installed at a shaft or drift mine and give the size of the air shaft or the dimensions of the drift portal.

5. Give the elevation at the fan location; if the intake or outlet for the air is at a different elevation, give this also.

6. If a steel hood is required for an air shaft, give the air shaft dimensions and advise whether explosion doors are desired. If the air shaft is rectangular in shape, give its dimensions adjacent to the fan.

7. Advise whether steel side drifts with roofs are desired. These drifts may also be built with masonry and are intended to connect the fan inlets with mine opening. They are necessary with all exhaust and reversible fans. A blowing non-reversible fan does not require side drifts.

8. If a request is made of the fan manufacturer to furnish motor and drive with the fan, give voltage and current. If alternating current is used, then give phase and cycle. State preference for flat belt, V-belt or chain drive. Direct connection is only practicable with small centrifugal fans.

9. Do not specify the size of fan required but leave this up to the manufacturer. In order to deliver a certain volume at a given pressure, a different type of fan may require a different size.

10. If an old fan is ventilating the mine, give the volume now obtained and the pressure the fan is producing. This data must be carefully read and guess duties eliminated. It is also advantageous to give the make and diameter, also the speed of the old fan at time of taking the data.

11. It is important that the data obtained in Item 10 is absolutely correct. In case the operator is unable to obtain correct readings, then a ventilation engineer should be consulted who is entirely familiar with mine ventilation.

12. If the mine is a new one, then a definite volume should be specified for its ventilation. Sufficient airway capacity should be provided so that the resistance will not exceed 3-in. water gage.

13. Request that the fan shaft be of hammered steel, .35 to .40 carbon, and that ample clearance be made around the driving connections. Ask the manufacturer to specify the diameter of the fan shaft under the hub and in the bearings and give the shaft length.

14. Specify that the fan bearings be of the double-ring oiling, self-aligning, dust proof, dynamo type and be fitted with split bronze oil rings. The length of the bearing should not be less than three times its diameter. In case of light high-speed fans, a good ball or roller bearing may be used, but stick

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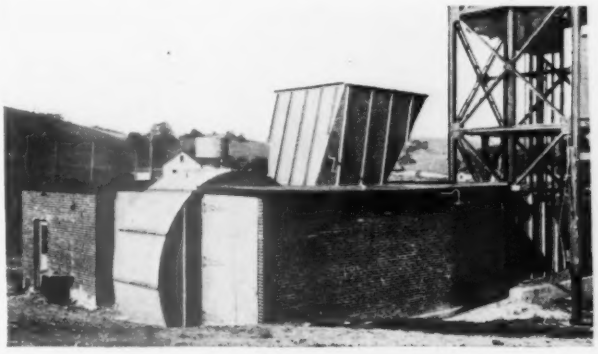


An 11-Foot Fan at a Pennsylvania Mine. Note the Design of the Evaseé Discharge Chimney Guaranteeing Slow Expansion and Improved Performance

Modern Mine DRAINAGE Practice

By E. E. KENDALL*

OUR more modern methods of mine drainage include various systems to take care of the many different operating conditions encountered in this country. In the bituminous coal industry it is the usual custom to use the enclosed automatically oiled type of piston pump for gathering the water from working places and discharge this to a central sump or pumping station. From this point the water is then handled by large horizontal centrifugals or vertical centrifugals of the turbine type and discharged through bore holes or shaft to the surface. By proper advance planning this type of system can be worked out so that several piston or plunger pumps can be used for discharging to a central sump and none of them will be equipped with very long suction lines until they can be moved to another location discharging into another large sump.

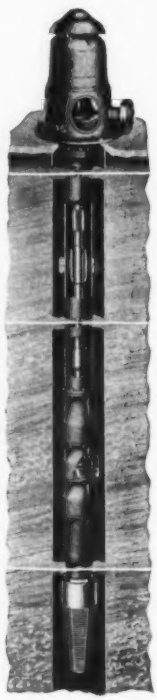
It is now possible to equip large sumps with deep well turbine type of pump built in a compact unit with the stages directly below the motor and the discharge connected to bore hole in the usual manner. This type of equipment is especially valuable for automatic control as the pump is located in the sump and no elaborate starting equipment or priming equipment is necessary. An ordinary float switch together with automatic starter is all that is required for stopping and starting the pump. Another advantage of this type of main pumping station is where the water is very bad and it is necessary to build the pump of special metal, such as chrome nickel alloy to resist the acid water. All parts of the pump coming in contact with the liquid can be built of this special metal at a low price compared with a special metal horizontal centrifugal pump together with the necessary priming equipment and control equipment required with this type.

If it is possible to have a large sump with a dam above the pumping station so that the water will flow to the pump, the same result can be obtained by the use of standard horizontal centrifugals without expensive automatic control.

In modern mining as much care should be taken in laying out the proposed drainage systems as is used for other phases of operation. This should include minimum lengths of suction line, pipe of ample size, and minimum friction head. It is also very important that the suction lines of pump collecting water from working places be equipped with dirt trap which will eliminate frequent shutdowns and supervision. Discharge lines should be of ample size and installed with a minimum of elbows.

A rapidly increasing number of bore holes are being used and discharge lines in these bore holes should be carefully installed. For the best practice here the reader is referred to the American Mining Congress Standards which were compiled by the mine drainage committee of The American Mining Congress. These standards can be secured from The American Standards Association, 29 West Thirty-ninth Street, New York City, at 40 cents per copy.

Acid water is becoming an increasingly important factor in mine drainage and the most modern method of meeting this problem is to use pump and pipe lines made of special material.



It is now possible to have pumps built entirely of chrome nickel alloy which is successfully handling the worst mine water in the bituminous coal field. The most successful metals for this purpose seem to be castings containing up to 12 percent nickel and from 18 to 28 percent chromium.

Pipe lines for handling acid water have always been a serious problem and many types of lines have been successfully used, among which are wood, fibre, cement lined cast iron, rubber lined pipe, and pipe made of hard rubber.

The best type of pipe to use will depend on various factors including the amount of protection offered from falls, length of service in one location, and whether or not the line is laid over a mine floor where it is subject to high corrosion rate from the outside.

In former years it was necessary to de-water these old workings with pumps located within the old mine, discharging through shaft or bore hole. This necessitated keeping up tracks, trolley, and air currents so that the pumping stations would be available for maintenance. However, more modern methods of taking care of these propositions is to put down drill holes at the right location and equip these drill holes with the deep well centrifugal, or turbine type of pump, with the motor at the surface.

With this type of mine drainage it is possible to let the old mine fill up to a higher point and the water can then be pumped at off-peak periods which will greatly reduce the power cost. Other factors of saving are that the pump is operated directly from the alternating current line and it is unnecessary to keep up haulage road and air course in the old workings.

When this type of mine drainage is employed it is important that substantial barriers be built around the bore hole in the old mine so that there will not be any falls or cave-ins around the pump. These barriers should be built so that the water will flow through them to the pump with relatively low velocity and yet hold back all foreign material that should not get to the pump intake strainer.

When necessary to recondition a pump of this type the entire unit can be withdrawn through the bore hole to the surface and the pump put in good condition.

The fact that there are approximately five tons of water handled per ton of coal mined in the United States offers conclusive evidence that mine drainage is a major problem of operation and in modern mining practice this fact will be taken into consideration by the engineering and operating department to keep down the cost of coal production.

Modern mine drainage practice in the clay industry, in the metal mines, and the anthracite coal industry follows generally the methods employed above, which refer particularly to the bituminous industry. However, special systems must be worked out to meet certain operating conditions. Drainage tunnels can frequently be employed to good advantage where their first cost can be justified over a long period of operation.

* Sales Engineer, The Deming Co.

Underground TRANSPORTATION

By C. C. AUSTIN*

THE cable reel locomotive and the storage battery locomotive were both introduced about the same time but the cable reel locomotive was perfected before the battery locomotive. There has been a constant battle between these two types of locomotives in gathering service.

Gathering behind mechanical loaders, is a field in which the battery locomotive has proven to be supreme, but the height of the loading machines confines them to thick seams. The advantage of the battery locomotive in this work lies in the absence of trailing cables and its ability to go any place with no preparation beyond that of laying track.

Modern loading machines load so rapidly that large locomotives are required to serve them properly, and the battery locomotive has met these demands.

When the coal has been delivered to a common parting by gathering locomotives, it is hauled to the shaft bottom by main line locomotives. Large mines use trolley locomotives because the work is beyond the capacity of battery locomotives. The performance of these main-line trolley locomotives can be truly called superb. Conditions are severe. Underground inspection is always difficult, repair facilities are frequently inadequate, grades considered normal in mining practice would send a railroad man to the madhouse, the running friction of the cars is three to four times as great as surface railroads and yet these trolley locomotives work day in and day out with maintenance records of which any railway man could be proud.

In smaller mines, the storage battery locomotive is extensively used for main-line haulage with success equal to that obtained by its big brother under conditions equally severe.

Gaseous mines requiring permissible equipment present a more difficult problem than non-gaseous mines.

The United States Bureau of Mines has approved storage battery locomotives constructed according to Bureau specifications which make them safe in any gaseous section. Most Permissible locomotives are used in gathering work, but in some mines they are used on main haulage.

The record of the Permissible locomotives in the gaseous coal mines in the United States and Canada is well nigh perfect.

The success of the Permissible battery locomotive created a demand for enclosed cable reel locomotives on the part of those operators who favor trolley equipment, which could be used for gathering work and this type is on the market. It is not approved by the Bureau of Mines, hence it is not Permissible, although the Bureau tests its individual parts.

The advent of the Permissible storage battery locomotive opened up a new method of mining in gaseous mines called "Wireless Mining Method," whose success depended upon the operation of the power truck. This power truck is a Permissible motor driven truck, made to carry a battery big enough to operate a cutting machine. Power trucks furnishing power for the cutting machines, together with Permissible locomotives for haulage, render permanent underground wiring unnecessary, thereby eliminating a serious hazard. Wireless mining has been in successful operation for over ten years with satisfactory operating and financial results to the mining companies using it.

Metal mine haulage constitutes a problem totally different from coal mine haulage. Shafts are small and drifts are generally narrow and crooked. The small openings limit the size of equipment which can be taken underground and the metal miner's attitude toward everything underground is that "it is too big and not strong enough."

Men can push cars in narrow drifts, but the sharp curves curtail their limited capacity. Shafts are generally so small that only small, hence inefficient, mules can be taken underground.

Most metal mines work their ore bodies on numerous levels and frequently the ore available on any one level is too small to justify a locomotive and far too great to tram by hand economically.

This causes the demand for small locomotives no larger than the ordinary mine car. It can be placed on the cage and taken to any level, thereby providing electrical haulage where neither men nor mules can work economically. Its use has decreased mining costs in many parts of the world and in some cases has made it possible to mine ore otherwise unprofitable.

The one case in metal mines where ideal haulageways can be prepared is that of mines whose ore bodies are big enough to permit constructing ore passes from the upper levels to the lowest levels upon which a permanent haulageway can be installed. In such cases, the main haulage drift can be laid out straight and can be driven to a pre-determined grade.

The inherent advantages of the storage battery locomotive, however, have won for it preferred consideration in the metal mines, particularly if the ground is heavy and requires extensive timbering or if the drift is wet.

Modern battery locomotives are made in a wide variety of sizes with different types of transmissions and different sizes of motors to meet widely varying conditions, hence haulages which were considered impossible for battery locomotives a few years ago are reliably handled with them today.

The battery locomotive is generally used in tunnel work. It requires no preparation to permit it to keep pace with the constantly advancing face, whereas the trolley wire must be constantly extended to keep up with the work if trolley locomotives are used. There is no electrical hazard in using a battery locomotive and the trolley danger is particularly bad in tunnel construction.

Improvement in locomotives has more than kept progress with the advance in tunnel driving as has been proven in driving the tunnels in the Metropolitan Water District of California in the past two years. Battery locomotives have proven to be almost 100 percent reliable under this severe work.

An attempt to look into the future does not disclose very much probable change from present designs of locomotives unless some radical invention comes into use, such as transmission of power without wires, the use of atomic power, the invention of a storage battery of far greater capacity than available at present occupying less space and requiring much less time for charging. None of these things, however, seem to be at all imminent.

* President, Mancha Storage Battery Co.

PREPARING COAL of Higher B. T. U. Value

By E. J. BURNELL*

PRESENT-DAY methods of mining result in coal being brought to the tipple containing a high percentage of small coal and too high a percentage of dirt (often 20 to 30 percent) to be salable. This coal is too small to permit hand picking.

It is generally agreed that the larger sizes of coal can be more economically cleaned by hand picking.

The ash content of coal is an important factor in determining its marketability, the higher the ash content the lower the value of the coal; while if the ash approaches 20 percent, it is most difficult to dispose of the coal.

It is evident, therefore, that the value and marketability of the smaller coal, which is a large portion of the mine output, are vital factors affecting the profitable operation of the mining properties. Even if there is a ready market for the larger coal, a fair selling price must be obtained for the smaller sizes.

As a rough figure, if the ash percentage in the small coal exceeds 10 percent, washing should be considered. The market is becoming more and more critical.

Washing Methods

The necessity of cleaning coal led to the invention of many systems or devices, which tackled the problem from various angles. To name only a few—Elliott introduced a "Trough Washer"; Shepherd, a "Bash Jig"; Draper, the "Draper," a system which had an upward spiral current of water inside a circular vertical tube. The foregoing, which were used with varying degrees of success in Europe, have now run their course, and are not being manufactured today; in fact, many have been dismantled and replaced by more up-to-date plants.

On the American continent such jigs as the Luhrig, Robinson, New Century, Stewart, Shannon and Foust were extensively used, but have also been superseded.

Essential Characteristics of a Cleaning System

Cleaning costs vary to a considerable degree, and in order to arrive at an approximate cost, and profit from the separation, it is necessary to review certain factors, which include the following:

(1) Power and labor entailed in conveying small coal to plant.

Close-up View of "Electric Eye" "Auto-Constant" Refuse Discharge Control

(2) Power and labor required for cleaning.

(3) Power and labor required for disposal of refuse.

(4) Reduction in quantity of cleaned product (due to discarding dirt).

(5) Loss of good coal with dirt, if an inefficient plant is installed.

(6) Labor in loading out cleaned coal.

(7) Interest on capital outlay.

(8) Depreciation on capital value of plant, renewals, etc.

(9) Maintenance cost.

(10) Value of the cleaned coal for metallurgical, steam, commercial or domestic purposes.

These items are of a variable nature, according to the general layout of the preparation plant, location of cleaning plant, quantity of loss by dirt, and the capacity of the installation.

It may be pointed out that the prime capital cost is only one of several contributing items to outlay, and should, therefore, be considered collectively with all others, when deciding which is an economical plant and layout.

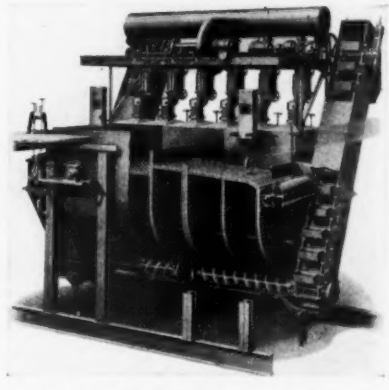
It is most difficult to give definite reliable figures for general use, as naturally the conditions at each mine vary, from many standpoints, such as cost of power, difference in price obtainable for cleaned coal in different markets, etc. The balance of earning capacity may be arrived at by treating the foregoing items individually for each mine or installation.

In studying new tipple layouts, care should certainly be taken to make satisfactory provision for the installation of a reliable cleaning plant, as, if sufficient foresight is exercised, the cost of handling may be kept at an absolute minimum, which means less labor, breakage and power; as well as no inconvenience. If a cleaning plant has to be added later, and no provision has been made for it in the original layout, it is not always possible to obtain an ideal arrangement, or one that will avoid the faults named. This applies particularly where restricted sites are concerned.

Sufficient siding accommodation should be provided for the ready handling of traffic, as the cleaning plant should never have to stop for cars, due to congestion.

Continuous running (not intermittent) of an efficient plant means good uniform results. A small storage bunker for uncleaned coal is of great assistance to assure uninterrupted operation.

In order to shorten the path of coal to the cleaning plant, the latter should



Link-Belt Simon-Carves Wash Box with "Electric Eye" "Auto-Constant" Refuse Discharge Control

be as near to the tipple screens as possible. This arrangement generally facilitates the central collection of refuse from pit, screens, and cleaning plant, which means less labor. The plant should be designed on sound engineering lines, attention being paid to simplicity, access for lubrication and adjustment, and ruggedness of machinery. Machin-

(*Concluded on page* 51)

* General Sales Manager, Link-Belt Company.

The MINE LOCOMOTIVE—Development and Features

By W. H. SMITH*

EARLY in the final decade of the last century the electric locomotive made its debut in underground coal mining service. Although this was a tool which, later, was to revolutionize the mining industry, slight notice was devoted to the introduction of this method of quickly and reliably transporting coal.

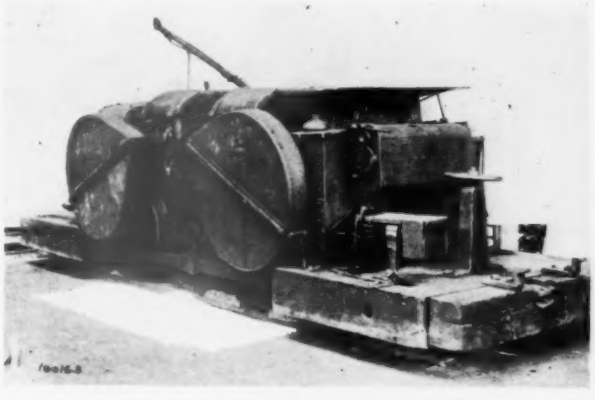
The operating companies were apathetic towards this new machine and were reluctant to change from the old to the untried and unproven means of hauling coal. True, certain of the larger coal companies, recognizing the possibilities of this modern machine, made trial installations, from time to time, in their properties. It was not, however, until the turn of the century that the mine locomotive really began to receive serious consideration.

Following a more general acceptance, the manufacturers, including the Westinghouse Electric Company, in conjunction with the Baldwin Locomotive Works, began to devote more effort and time to research and development, with the object of producing more efficient, hence more economical machines—economical, chiefly from an operating and maintenance standpoint with consideration also being given to the manufacturing angle. Also, the scope of the activity was broadened to include various types and sizes of locomotives.

While, actually the mine locomotive has been constantly undergoing changes, not all of these have been wholly the result of effort on the part of manufacturers. More often suggested changes and improvements have been proposed by men in the mines who, in their various capacities, came in contact with locomotives in the properties in which they were employed. Many ideas so received were accepted and developed by the manufacturers and are to be found incorporated in today's modern locomotive.

It is but a natural result, that, with such cooperation between user and manufacturer and after such an extensive period of development, which, by the way is still continuing, the modern mine locomotive is a highly efficient piece of apparatus.

As an indication of this, consider the lowest height locomotive of similar size and capacity yet constructed—a 15-ton trolley type locomotive to be used in secondary haulage, developed by Westinghouse-Baldwin, and, within the past few weeks, placed in service in one of the mines of a large operating company in southern West Virginia. The feature of this locomotive is that it is but 32 in. high, utilizes two 110 hp. motors and is equipped with air brakes, which provide



An Early 20-Ton Haulage Locomotive

an ease and certainty of control, and make possible the inclusion of two additional features. One of these is air operated sanders, which makes it possible to direct a steady flow of sand directly under the driving wheels. The second is air operated control. The contactors are electrically controlled through a magnetically operated valve admitting compressed air to the operating cylinder. The contactors are closed against a powerful spring by compressed air acting on a piston in the air operating cylinder of the contactor. The contact pressure is sufficient to provide full-current capacity at all times, and the force with which the contactors are opened insures against welded contacts and arcing at the contacts.

In addition to the haulage locomotives, gathering units of both the storage battery and the trolley cablereel are procurable from practically all of the mine locomotive manufacturers. These are divided into two classes; the open type and the enclosed type. The enclosed types were devised in conformance with the modern trend of safeguarding the life and limb of the mine workman as well as the property of the mine owner.

In this class we have the Government approved storage battery type locomotive and the explosion tested type locomotive. While the permissible storage battery locomotive is the only unit, so far approved by the Bureau of Mines for operation in gaseous mines, the explosion tested type, also has its place in the scheme of coal mining. The safety and economy of each situation are the factors which largely determine the type of machine which should be applied.

One of the most recent equipment contributions devised to reduce the hazards of operation in gaseous mines, is the double drum vertical axis cable reel which is applied on the Baldwin-Westinghouse explosion tested type locomotive. The reel was designed to keep the positive and the negative leads separated at all times by providing for two single conductor cables, one on each drum. The reel consists of a single motor of which both the armature and frame are free to rotate and two separate drums. One drum is secured to the armature shaft and the other to the motor frame. Since there are two individual conductors each spooled on separate drums it is necessary to provide (1) independent movement of each drum to permit cables to unwind or wind at different speeds in the event a cable is caught by some obstruction, and (2) equal pull on the cables so that they will be spooled at equal speeds. In operation, the pull on the cables is produced by the reaction between field poles on frame and the armature. The forces exerted by these two are normally equal to each other. The pull on the cable is practically constant for different speeds of reeling or unreeling. When one cable has been unreeled more than the other, the drum on which this cable is spooled will rotate at higher speed until the slack is taken out. This arrangement provides an electrical differential which gives proper and independent action of each drum without the use of gears.

* Westinghouse Electric & Manufacturing Company.

Equivalent Orifice in Co-Ordination of Mine and FAN Characteristics

By **ROBERT R. ROBINSON***

THE question has often been asked, "Of what use is the equivalent orifice in controlling mine ventilation?" No doubt, insufficient knowledge of the correct definition of the terms and the significance of the relation between the mine equivalent orifice and the operating characteristics of the fan in use, prompts such a question.

The equivalent orifice is the net orifice of passage, or the orifice through which the air would flow without friction. It is possible that the formula, $E.O. = .0004\frac{Q}{\sqrt{h}}$, may not be absolutely accurate for mine work, but it gives us a measuring stick for comparison of varying conditions. It expresses a relation between volume and pressure.

Now, if an air stream flows through a tube, the drag of the air on the sides of the tube produces the same effect upon the net orifice of passage as the optical effect produced by looking through a straight tube (Figure 1). Sections taken through the tube will appear to be of different sizes, depending upon the distance of those sections from the eye of the observer. The apparent size of any section varies with the distance.

Then, if an obstacle is placed in the tube, the resultant orifice may be less than the smallest one apparently existing in the smooth tube.

Now, with a flow of constant velocity, pressure is highest at the entrance end and varies directly with the length of the tube. If the obstacle is placed in the air stream and the same pressure at the entrance end maintained as existed in the smooth tube, the volume of air emerging from the tube is reduced in proportion to the orifice reduction.

However, if a constant volume is to be maintained, as is required in mine ventilation, the pressure at the entrance end of the tube must be increased, or the obstacle removed. The pressure increase required then will be an amount equal to the sum of the original pressure and the increase necessary at the new orifice. Since pressure varies as the square of velocity, and velocity inversely as the area of the orifice, it can be readily seen that one obstacle may be the cause of tremendous pressure rise and hence of power increase.

For instance, suppose a volume of 100,000 C.F.M. passes through a tube at a pressure of 3.2 in. or E.O. of 22.4 sq.ft., with a velocity in the smallest section of 1,415 ft. per minute, and an obstacle appears which requires, in order to maintain constant volume, a rise in mean velocity to 7,130 ft. per minute at the point where the obstruction occurs. Then there would be an increase in pressure at that point which may be expressed as follows:

$$\left(\frac{7{,}130}{4{,}000}\right)^2 - \left(\frac{1{,}415}{4{,}000}\right)^2 = 3.05$$

So that the pressure required to pass the same volume that flowed through the orifice of 22.4 sq. ft. would be 3.2 + 3.05 or 6.25, and the equivalent orifice would be 16 sq. ft., while the power in the air stream would change from 50.35 A.H.P. to 98. This change in conditions would be equivalent to that produced by increasing the length of the tube 95 percent.

A number of obstructions of smaller proportions would have similar effect if they were placed in series so that all the air would be required to flow from one to the next. Then the sum of the pressure rises would determine the amount of increase in the static pressure for the entire system.

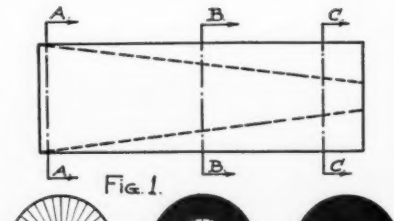
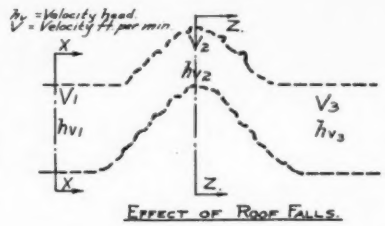


Fig. 1.



Effect of Roof Falls.

Fig. 2.

Explanation of Charts

Equivalent Orifice

In Figure 3 the E.O. is 22.4 sq. ft. at section AA. A roof fall chokes the airway and causes the resultant equivalent orifice to correspond to section CC, or 8 sq. ft., while the normal or average

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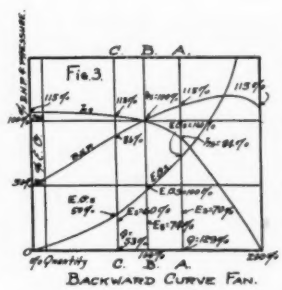

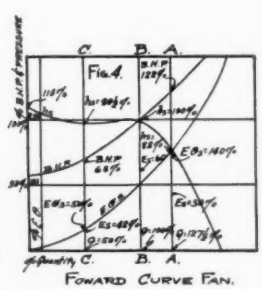

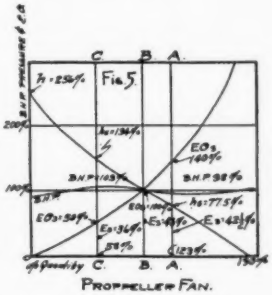

E.O.s—Equivalent Orifice based on static Head.
Es—Efficiency based on static pressure.
Hs—Static Head.
B.H.P.—Horsepower supplied to fan shaft.
Q—Quantity of C.F.M.

* Chief Engineer, Robinson Ventilating Co.

Modern MINE CAR Efficiency

By J. MILTON DUFF*

THE mine car is the most important piece of mechanical equipment in the mine. A car is not efficient simply because it may have a large capacity, or because it may handle or roll easily. Many factors must be considered in the design of the modern mine car, and what may be an efficient car in one mine, may prove to be very inefficient in another. But in any event, the efficient mine car should be of the largest practicable capacity, of convenient dimensions for easy loading and rapid dumping, and of resilient and substantial construction, so that in conjunction with proper running gear it will handle with minimum friction and with low maintenance costs.

The ideal mine car is that having the lowest ratio of dead weight to carrying capacity and with the lowest possible drawbar pull, but the complete attainment of this ideal is difficult of realization because of the element of first-cost and of maintenance. The ratio may be reduced by the use of lighter sections of more-expensive high-strength materials, maintaining the strength necessary to substantial construction, or the strength may be sacrificed to lightness by using lighter sections of the lower-strength materials and thus reduce the ratio, but probably at the expense of increased maintenance. Improved drawbar pull is obtained through the use of the higher-priced anti-friction bearings.

While the trend over recent years has been toward the steel mine car, the wooden body car still has some economic justification, not only on account of its lower first cost nor the fact that repairs can be made by ordinary labor in the average mine repair shops, but also to the circumstance that the wood body is not so readily attacked by mine water of high acidity.

Until recently, body plates in steel cars were made of soft open hearth steel, readily subject to corrosion, and with only the physical properties of steel of this grade. Its corrosion resisting qualities were improved through the addition of a small amount of copper, without, however, affecting the tensile strength of the steel. There are now available, commercially, certain special steels with greater corrosion resisting qualities, selling at a reasonable premium over the price of soft steel, and their use is often economically justifiable.

Recent metallurgical developments have made available a steel of about double the physical properties of ordinary soft steel, with much greater resistance to corrosion than copper bearing steel; the use of this material makes it possible to reduce the sections employed to about one-half the thickness of soft steel, but actual practice has been to use plate thicknesses about one-third less than soft steel to maintain the strength of the plates over longer periods. These steels are higher in first cost than ordinary copper bearing steel, but consideration must be given to the longer life and decrease in dead load resulting from their use.

Other materials are available to further reduce the deadweights of the cars, but are not practicable on account of their present higher initial cost.

Under the head of efficiency factors may be enumerated the proper car height for the system of mining employed; effective brakes which will stop the car without sliding the wheels, easy of application and of maintenance; spring or friction draft gear for larger and heavier or all-steel cars, permitting the starting of longer trips, and relieving the bodies of undue strains; the use of proper size materials to prevent distortion or sagging of bodies which might create friction through contact with the wheels, or otherwise prevent the free operation of the working parts of the car; running gear, with axles and bearings of proper carrying capacity and wheels of maximum diameter, of good quality, carefully machined and assembled; the use of good lubricants. Intentional disregard of these factors, to lower initial cost, will have its effect in causing heavy maintenance expense and shortening the life of the car.

The running gear is properly the foundation of the car, and if the running gear is inefficient the car as a whole may be regarded as unsatisfactory. Mine car wheels have been the subject of a vast amount of experimentation over a long period of years, and the patent bibliography on this subject is extensive.

Each mine car manufacturer has made his contribution, and it has been a long step from the earliest coal car wheel, with its solid hub pierced with an oil hole to admit oil to the axle journal, and oiled daily or per trip, to the highly efficient anti-friction bearing wheel of the present day, which is lubricated only semi-annually. A new development is an anti-friction bearing which is lubricated and sealed at the factory of its manufacturer and which, it is claimed, will operate without further lubrication. This style of bearing has given some satisfactory results in the industrial field, but it is rather new in the coal industry.

Claims were advanced by one manufacturer and another as to the merits and efficiency of his particular wheel and it was to arrive at definite comparative values that various tests were conducted between the years 1910 and 1916. Since then, other tests have been made by the U. S. Bureau of Mines at Pittsburgh, the results of which were published in pamphlet form. These various tests show lower bearing friction by the use of the anti-friction bearings, or a betterment of car efficiency. The percentage of savings shown by the anti-friction bearing is rather high for level track but drops off rather rapidly as the grade is increased. This one point must be considered carefully in figuring the efficiency of the modern mine car over the ones equipped with plain bearings.

The old practice was to use wheels of large diameter with axles no larger than was actually necessary so as to make the car easily handled. This meant higher cars and usually smaller capacity, due to high wheel clearances. The tendency with the modern mine car is lower cars for more efficient loading, maintaining or even increasing the capacity by increasing the length or width, lowering the flares and possibly depressing the bottom, and by the use of smaller wheels.

The anti-friction bearings have made practical the use of smaller diameter of wheels in connection with large diameter axles, under heavy loads and long hauls, without a great loss of efficiency. Some experiments are now under way with 8-inch diameter roller bearing wheels under large capacity cars. There is no doubt but that in this particular case efficiency is sacrificed for additional tonnage. It must be remembered, however, that anti-friction bearings are not totally foolproof—they must be properly installed and require a certain amount of attention if they are to give efficient results.

* Consulting Engineer, Phillips Mine and Mill Supply Co.

WEIGHING as a Factor in Controlling Production Costs

By E. B. SMITH*

THE function of weighing equipment in industry is twofold; just as an instrument by which the successors to the alchemists compound their formulas or mixtures in transmutation processes, and, second, as an accounting facility. In the first instance the weigher proportions material in terms of the physical or chemical properties of the material itself; the function is pure measurement. In the second instance, quantities of material are measured with regard to unit costs either for barter, or service, or purposes of periodic or running inventory; the function of measurement is combined with that of a cash drawer or accounting machine accessory. Although the fields of utility of weighers developed for each of the primary purposes somewhat overlap, yet each purpose requires forms essentially different.

Although they vary widely in form, types suitable for the first named purpose do not vary widely in principle. Common experience includes the precision analytical balance of the chemist, the "beam ladder" scales, such as are used by bakers and foundrymen for compounding mixtures, and the batching weighers used for proportioning the ingredients of concrete.

That the second purpose has by far the greater economic purpose will be instantly recognized. The types necessary to meet its requirements are of so great a variety of kind, size and manner of performance as to make listing them impossible. Some of the more important may be briefly mentioned and their influence in controlling costs in the mining industry catalogued.

Since material cannot be weighed for determination of quantity until it is independent from all other material of different kind, weighing as a factor in controlling costs in the mining industry does not enter until after the material is produced. For instance in the Upper Great Lakes region ore is weighed by the train load on railway track scales for the purpose of determining the quantity produced and the cost of transportation. Again in the bituminous coal mining industry, coal is weighed as it comes from the mine, for the purpose of determining the wages of the miners. In both these basic cases, although production costs are not determinable until the operation is performed, yet the weighing operation cannot be performed at any time in the production routine before the material is virtually ready for delivery to the customer.

Fundamental facts quite frequently overlooked in coal mining layouts and whose consequences have a profound effect in controlling production expenses are that the income from the operation of a mine is measured on its scales, that the scale is the key instrument in fixing the relation between the tonnage and the cost of producing it, and that the relation is unalterably fixed long before the customer's checks are deposited at the bank. Instances are replete where weighing is being done on inadequate equipment under indifferent conditions of maintenance, the net result of which contributes materially to the perpetual and aggravating discrepancy between tipple weights and shipping weights. The remedy is adequate scales, better maintenance, and intelligent control of tare weights. The extent to which this comment is true is forcefully illustrated by the fact that some years ago when the United States Bureau of Standards began an investigation of weighing conditions at coal mines weighing equipment was so universally poor that although twice the allowable limits of error given to ordinary scale was conceded, yet 75 percent or more of tipple scales failed to come within those wide limits. Intelligent attention to selection of equipment, maintenance and operation, has greatly mitigated that deplorable condition, and continues to be the only remedy.

For purely psychological reasons, opportunities for eliminating waste of capital expense and maintenance costs exist in the coal mining industry through an apt choice of methods of determining the wages due miners. The reference here is to the practice of paying miners a flat rate per loaded car instead of on a tonnage basis. In the first instance cars come out of the mine loaded to the lowest acceptable limit; in the second they come out loaded to the mine roof. The results are that where miners are paid by weight the number of cars required to handle the volume may be 50 to 75 percent of what it otherwise would be, and maintenance costs not only of cars but trackage and motive power are reduced in approximately the same ratio.

No form of commercial measurement even approaches the precision with which weighing in ordinary transactions may be performed. The overgrown demands for rigorous accuracy, and the business necessity for a variety of functions has created in our commercial routine a well defined tendency to grade weight records with regard to authenticity. That is to say, a modern commercial weighing machine must not only weigh goods but it must impart to the parties at interest a feeling of confidence the weights are uncontroversially correct.

In the mining industry authenticity is above all other things a necessary attribute of weight records since the lack of it affects miners' wages, lessors' royalties, operators' gross revenues, and rail transportation costs, and since in these different matters the same weight record serves the purposes of each. Therefore for these purposes scales are designed to the end of eliminating the errors of human observation, in short, not only to present to the observer a plain indication of the weight of the imposed load but also to make automatically a printed record of it.

Thus in the Upper Lakes region, railway track scales used for weighing iron ore are fitted with automatic weight recorders which weigh each car in motion when coupled in train. In the bituminous coal mining industry scales are designed to show the weight of coal per mine car and to automatically record it without other human operation than posting the records on the tipple sheet. In each instance, the records serve other purposes as well as the primary ones. The existence of the mechanically made permanent records is a substantial factor in attributing confidence to the incidental transactions, and the elimination of controversy as to the amount of material involved.

Aside from insuring authenticity of weight records, speed of operation is an essential function of a weighing machine in the mining industry. Thus, consider a bituminous coal mine where the weighing is done by hand with an average length of weighing time of a given amount. If with the same degree of

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* Sales Manager, Streeter-Amet Company.

Desirable LOCOMOTIVE BATTERY Characteristics

By NORTON J. BOND*

A SPEAKER, before a recent meet- of the Rocky Mountain Coal Mining Institute, said, "The romance of coal mining is rapidly fading away."

In a sense, he was right. The old mine mule, the picturesque old-time miner with his oil lamp—in fact, many of the practices that have long been associated with the business of mining, and which lent glamour and romance are fading. In their place has come a new romance—the romance of modern industry—the tendency to do things in a more efficient, a more business-like, modern manner.

Increased operating efficiency — whether in the coal or metal mine— must provide the means to offset this increased production cost. Mechanized processes are essential.

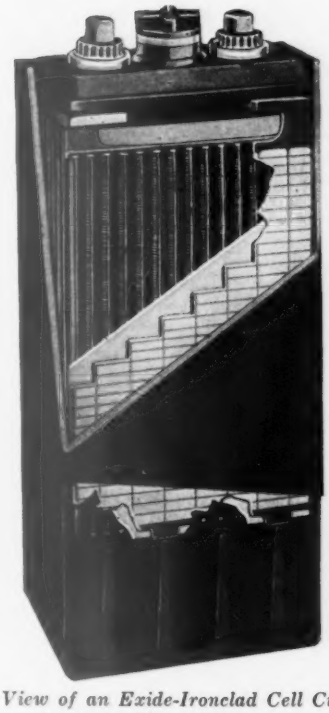
However, the use of coal cutting machines, mechanical loaders and other devices for speeding up production are of little value if they are not supplemented by an equally efficient haulage system. Regardless of how rapidly coal or ore is mined, nothing is to be gained if cars cannot be brought up and hauled away with corresponding efficiency.

Recognizing this, in the great majority of cases, the operator is confronted with the problem of deciding exactly what type of haulage system is most effective and most economical for his purposes.

It is our purpose, in this brief article, to call attention to the merits of the storage battery locomotive, with particular emphasis upon the characteristics of the battery chosen to propel it.

As every mining man is aware, the battery locomotive's installation is most simple. Wherever rails can be laid, this type of locomotive can be used. No bonding is necessary; no overhead wires; it is the most flexible type of haulage unit available. It has all the power—depending upon the battery—required to haul the heaviest loads. It is easy to maintain and usually is charged at off-peak times so that bills for current are reasonable. So highly developed has this type of locomotive become, that the "permissible type" of storage battery locomotive is the only one licensed by the Bureau of Mines for use in gaseous mines.

Naturally, the chief reason for the battery locomotive's performance lies in the storage battery with which it is equipped. Upon this important bit of equipment depends the loads that can be hauled, the grades that can be negotiated and the speed that can be maintained. It is of paramount importance, therefore, that the characteristics of a storage battery be considered carefully before the decision is made to purchase a particular one.



View of an Exide-Ironclad Cell Cut Away to Show Construction

The chief, desirable characteristics of a storage battery are: 1st, power ability; 2nd, high maintained voltage; 3rd, high electrical efficiency; and 4th, ruggedness and long life.

All locomotive motors are "series" type motors, the speed of which vary as the voltage delivered to the motor terminals varies. For this reason it is important that a battery be selected which will maintain a good voltage at high rates of discharge as well as at low rates. The battery which possesses this characteristic is said to have a high-power ability. It is the possession of this characteristic which enables a battery to discharge at many times the normal rate and consequently to pull extra heavy trains or negotiate unusually steep grades.

Any decrease in the voltage of a locomotive battery is reflected in a corresponding decrease in the speed of the haulage unit. This is because the voltage of any storage battery decreases as it discharges. In some batteries, however, the decrease in voltage is slight and as a result change in speed is scarcely noticeable. In selecting a battery, therefore, for use in locomotive service, one should be chosen with due regard to the voltage it maintains throughout discharge, if a good locomotive speed is desired during the shift.

A characteristic very often overlooked when choosing a battery is that of electrical efficiency. There are two ways of describing this characteristic, but only one of them correctly expresses the power efficiency of a battery. This is the term kilowatt-hour efficiency, which means the ratio of power (in kilowatt hours) delivered by the battery, to that required to restore it to a fully charged condition. Expressed in simple terms, this means that the battery with a high kilowatt-hour efficiency will return in useful work, a high percentage of the current required to charge it. Naturally, the higher the power efficiency, the more economical the battery is on charge.

While it is quite possible to obtain storage batteries combining high-power ability and (or) high-electrical efficiency with maintained voltage, it is a more difficult matter to obtain this combination in conjunction with the quality of ruggedness and long life.

It is a relatively easy matter, of course, to construct a battery having thick plates and therefore able to withstand more abuse than plates of normal thickness. But in securing durability by this means, other desirable characteristics would be sacrificed.

The battery manufactured by The Electric Storage Battery Company, of Philadelphia, employs a positive plate that instead of having the conventional grid upon which the active material is pasted, confines the active material within a number of flexible, hard-rubber tubes. Each tube has numerous fine slits cut into it from each side, leaving a solid strengthening rib where the slits do not meet, extending along the sides of the tube from top to bottom. Within each of these tubes, and consequently in close contact with the active material, is a metal core, burned to a connecting bar at top and bottom of the plate. The top bar is burned to a "strap," and terminal post, as in the ordinary cell.

* Electric Storage Battery Co.

Choosing the Proper RAIL BOND

By PLINY P. PIPES*

THE power distribution system in a coal mine is composed of the positive feeder and trolley system on one side and the track return circuit with negative feeders on the other side. In all cases the length of these circuits for all practicable purposes is equal. Therefore, it is very important to maintain the track return circuit so that it will afford equally as good electrical return circuit as the positive feeders. Although the bonds on the track joints ordinarily represent less than 10 percent of the length of the return circuit, the choice of size and length of bond is very essential so as to provide maximum efficiency at minimum expense.

Undoubtedly there are millions of kilowatt-hours of energy wasted annually in the coal mining industry due first to the misapplication of rail bonds and second to the improper choice of a bond for a given condition. Experience from actual contacts in hundreds of mines during the past several years has definitely proven that in a very large number of cases bonds are not properly applied due to lack of instruction and inexperience of the bonding crew. One case recently came to our attention where one of the men in a track gang was handed some bonds and welding rod and told to go in the mine and apply them without having had any previous instruction and experience as to how welded bonds should be applied. Not only was the investment in bonds in this case completely lost but also a very great expense was incurred in power loss and electrical maintenance costs due to poor voltage resulting from poor bonding.

The purpose of a rail bond is to conduct current efficiently from one rail to the next, and to be able to withstand without failure the normal mechanical vibrations experienced in service. In choosing a rail bond, therefore, the essential consideration is largely proper current capacity with low resistance at a minimum of expense, resulting in low voltage drop and low power loss. The accompanying chart (Figure 1), illustrates clearly the effect of cross sectional area and length of strand on the current capacity of a rail bond. It will be noted that as the length of a bond exceeds 35 or 40 in., the current capacity approaches that of an ordinary feeder cable with equivalent area. However, for shorter lengths of bonds the current capacity per thousand circular mils area increases very rapidly. These curves were arrived at from actual laboratory tests wherein the bonds were installed on the rails without angle bars attached so as to get the true capacity of the bond alone.

Rail bond strand in general is composed of 37, 61, 91, and 127 wires, depending upon cross sectional area and the length of the bond manufactured. On the shorter lengths of bonds it is very essential to use the finer wires in order to provide sufficient vibration life in service. On the longer bonds the coarser wires will provide sufficient life and will better withstand the abuses that exposed bonds usually encounter in mine service.

Since over 90 percent of the resistance of the return circuit, and in most cases over 50 percent of the distribution system resistance is in the rail itself, it is very important to give careful consideration to the size of rail from the electrical conductivity standpoint as well as from a mechanical loading standpoint. Even though the cost per circular mil copper equivalent of steel rail is about twice that of copper feeder cable, it is sometimes wise to choose a heavier rail than present wheel loads would justify in order to provide for increased electrical and mechanical loads in future. When additional electrical loads are added in a given section of a mine, it sometimes becomes necessary to add negative feeder cables parallel with the tracks and tap in to the cross bonds every few hundred feet in order to provide sufficient voltage at the working face. The cost of this additional copper and labor could easily have been offset in the beginning by the use of slightly heavier rail and in turn a much better haulage system would have been provided.

It is often difficult for the mine operator to decide definitely whether to use a 2/0 or 4/0 bond on a given rail return circuit. The choice of a bond in this case depends not upon the size of the rail or upon the amount of positive feeder at that location but upon the amount of electrical power that is to be transmitted. The difference in yearly power loss per joint between a large and small bond represents an amount of money that could be used annually for the retiring of the additional investment placed in a larger size of bond. If we equate this yearly power loss against the increased yearly cost of the larger bond, we arrive at the

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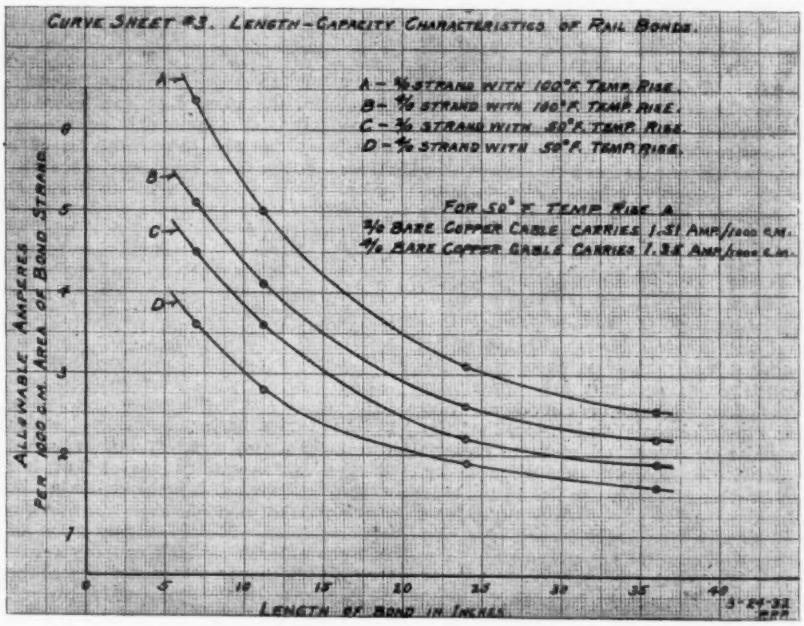

CURVE SHEET #3. LENGTH-CAPACITY CHARACTERISTICS OF RAIL BONDS.
A - 4/0 STRAND WITH 100°F. TEMP. RISE.
B - 4/0 STRAND WITH 50°F. TEMP. RISE.
C - 3/0 STRAND WITH 50°F. TEMP. RISE.
D - 2/0 STRAND WITH 50°F. TEMP. RISE.
FOR 50° F. TEMP. RISE A
3/0 BARE COPPER CABLE CARRIES 1.51 AMP./1000 C.M.
4/0 BARE COPPER CABLE CARRIES 1.38 AMP./1000 C.M.
ALLOWABLE AMPERES PER 1000 C.M. AREA OF BOND STRAND
LENGTH OF BOND IN INCHES
3-24-32

Figure 1. *This Chart Clearly Illustrates the Effect of Cross Sectional Area and Length of Strand on the Current Capacity of a Rail Bond*

* Engineer, Transportation Dept., Ohio Brass Company.

BEARINGS—

A Feature in Maintenance Cost

By F. O. BURKHOLDER*

ANTI-FRICTION bearings in coal mining machinery are undoubtedly subjected to as severe a service as is probably encountered in any industrial or machine tool application. A great deal of time and effort has already been expended in properly designing the mountings of anti-friction bearings for the various units that are used in the mining of coal. It is next to impossible to design and build adequate seals that will positively exclude water, dirt, and foreign matter from the housings and prevent it from contacting the bearings, which will eventually act as an abrasive medium in producing premature wear in the balls, retainers, and raceways of the bearings.

When this excessive wear occurs the usefulness of the anti-friction bearing is impaired, and it then becomes necessary to install a replacement. There are two methods of accomplishing this.

The first is to replace with a new bearing, which in most cases proves to be very expensive, especially when this replacement feature has to be contended with at relatively short intervals of operating time. To combat this it is advisable to consider the feature of having the bearing reground; however, the bearing has to first be examined to determine whether the rings are still in condition to permit their being repaired satisfactorily.

In operating coal mining machinery the bearings are sometimes allowed to continue functioning even though they are worn to the extent that their efficiency has been reduced to a point where they are an expense rather than a saving. Examination of some of these bearings, after they are finally taken out of the unit, will show that the rings have worn beyond the point of efficiency, and it is impossible to repair them. If, however, the rings have not been subjected to excessive abuse they are in condition to be economically repaired.

By this is meant that the bearings can be disassembled, the retainers and balls discarded, the wearing surface of the raceways which has been worn to depths not to exceed .005 to .015 depending upon the size of the bearing, can be ground in such a manner that the worn surface is removed and a clean hard surface restored which is now ready to withstand another attack of the severe forces which it will encounter in mining application.

All this is made possible by the fact that all high grade ball bearing manufacturers use an alloy steel designated as SAE 52100 for both the inner and outer rings which has a carbon content of about 1 percent and a chromium content of approximately 1½ percent. The manganese, phosphorus, and sulphur content are within a fraction of 1 percent. The large carbon content is the primary factor in giving the steel its hardness of approximately C-63, as measured on a Rockwell Hardness Tester. The chromium content gives deep penetration of uniform hardness to the very core of the ring.

In addition these elements produce an alloy steel which when properly hardened can be subjected to very high pressures without being unduly deformed. This means that both the balls and the races have an allowable stress and strain factor that is far in excess of most other types of alloy steels.

From this it can be readily understood why it is possible to remove the worn surface of ball bearing rings and present a surface that is every bit as good, as hard, and as wear-resisting as the original surface of the rings when the bearing was new. By adding new balls and retainers to these reconditioned rings is produced a bearing that is, from a service standpoint, equal to a newly fabricated bearing.

A great many complaints have been registered with bearing manufacturers that a replaced bearing, either new or repaired, does not, on an average, give the service that the original new bearing rendered. When it has been determined that a bearing is to be replaced the usual procedure is to take a new or reground bearing and place it in the unit without giving any consideration as to whether the housing bore or the shaft diameter have been worn in size or distorted and worn out of shape. It is, therefore, imperative that a careful check of the shaft and housing be made before installing the replacement bearing.

In cases where alignments, housings, and shafts have been taken into consideration, yet nevertheless the bearings did not function satisfactorily, or give the length of service that was received in the original installation, look to the method of excluding foreign matter. A vastly important item is the type of seal which has been used to retain the lubricant and exclude the dirt, foreign matter, and water, all of which are highly detrimental to the successful operation of the bearing and which in a short time destroys the exceedingly accurate and highly finished surface of the balls and races. It is recommended that the maintenance man be acquainted with these facts, that it is almost as important to check and replace the closures as it is to replace the bearings themselves.

In the majority of cases the original equipment has been manufactured and assembled under perfect working conditions, whereas the surroundings for replacing the bearings are far from ideal. It is therefore in order that a word of caution be given to cleanliness in the handling of all parts that come in contact with the bearing, whether it is directly or indirectly accomplished.

Incorrect lubrication of any mine application by the maintenance man will sometimes cause an early failure of the bearings, so if no instructions are given as to the correct type of oil or grease to use, it is advisable to secure the advice of the company who manufactured the unit, any anti-friction ball bearing company, or any company manufacturing the various high grades of lubricants. This will eliminate the possibility of a type of grease being used that does not give adequate protection to the bearings in certain parts of the operating unit which are exposed to dirt and foreign matter, that cannot be effectively excluded by any other means than the correct type of grease lubricant.

Again, electric motors and ventilating fans may possibly require oil lubrication, due to the high operating speed. This oil, at all times, should be of a neutral mineral base, and contain a minimum amount of acids which should not exceed the corrosion resisting properties of ball bearings, which is a minimum for this type of alloy steel.

If careful consideration is given to the various items outlined above undoubtedly bearings replaced in the mine car applications, whether they be new or repaired bearings, will give as good service as previously obtained from the original bearings.

* Vice President, Ahlberg Bearing Company.

AIRDOX

Preparation for Machine Loading

By EDWIN H. JOHNSON*

THE real test of efficiency in face preparation is to be found in those mines which have mechanical loading equipment and which need to get high tonnage from the mechanical loading units without paying the penalty of reduction in grade and marketability of the coal. An increase in the rate of loading at the working face is too often accompanied by a serious increase in the percentage of fine sizes produced. Most of the very high tonnages that are reported prove upon investigation to be very low tonnage of valuable sizes of coal and high tonnage of the sizes sold below production cost. Where coal is mined for coke oven use or for a mine run market that is not critical as to grade of product, the so-called overshooting does not exact the same penalty in realization, although it has other bad features, such as damage to roof and extra hazards resulting from use of excessively large explosive charges.

Airdox is a solution that is meeting this situation satisfactorily in an increasing number of cases, through release of a large volume of air at the back of the bore hole, at pressures low enough to avoid destruction of the coal structure or damage to the roof.

In obtaining satisfactory tonnage from large machines, the importance of car shifting time looms very large. It is not uncommon to find 2½ gathering motor crews serving a single loading machine; and track switches maintained so closely behind the loader that car changes can be made in an average of 20 seconds.

The time required to move from place to place becomes even more important as the tonnage rises. To help in overcoming the importance of this delay operating officials are experimenting with longer undercuts. Presumably the places are being operated as wide as possible; the height is fixed by the thickness of the coal bed; and a deeper cut is the most logical answer in room and pillar mining to the requirement for more coal in the working place.

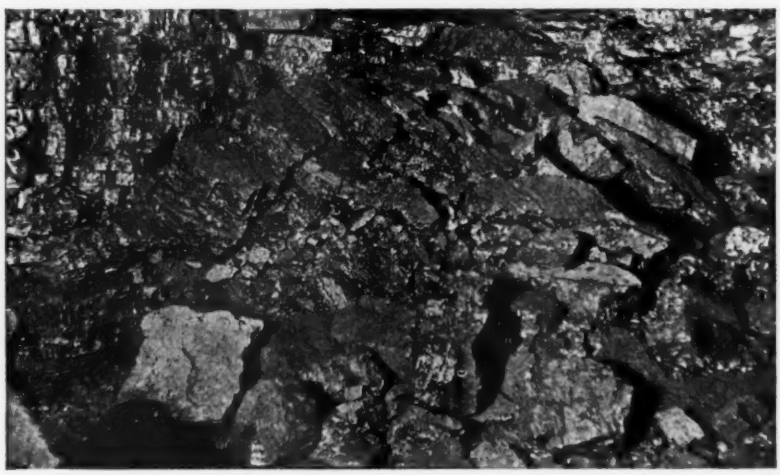
As the length of the cut increases several advantages and disadvantages appear. Trackwork, timbering and drilling costs are reduced, especially the drilling costs. The same number of post setups takes care of a larger tonnage and easily offsets the slight increase of power required for longer holes. The placement of holes becomes more important as the penalty for improper placement increases and consequently more intelligence and better attention to accuracy is required in the drill crew. With the deeper cut the importance of cleaning out the bug dust is greater; especially at the extreme depth of the cut. Also it is harder to get the dust out at the full depth of a longer cut. This presents one of the problems most easily slighted and therefore requiring especially close attention by the face boss.

The application of longer cutter bars to shortwall machines imposes an additional load on the motors and gearing, a load that in some cases is greater than the machines are equipped to handle. This factor is not so important where the rate of feed is controlled by hydraulic pressure, but on older types of shortwalls the penalty may be severe. A new answer to this problem has been found during the year in the development of thinner cutter bars designed to cut a narrower kerf. The thin kerf bar is capable of making a deeper undercut than the standard bar with the same consumption of power, and has the further advantage of decreasing the amount of bug dust per square foot of undercut face, with a consequent reduction in the percentage of bug dust in the screenings as well as a reduction in total screenings for the cut.

(*Concluded on page* 61

FIG. 1.—*Right Rib After Low Hole Has Rolled Out the Snubbing Cut. Cartridge in Place in Top Hole.*

FIG. 2.—(*Below*) *Same Face With Coal Rolled Out in Large Lump After Release of Cartridge in Top Hole*



* Manager, Airdox Division, Sullivan Machinery Company.

ANTI-FRICTION BEARINGS

for Mining Equipment

By R. C. BYLER*

ANTI-FRICTION bearings play an increasingly important part in the economical operation of mining equipment. They hold shafts in permanent alignment, reduce friction to a minimum, and operate smoothly in an atmosphere of grit, dust, dirt, and moisture. This, in terms of production, means less time and labor lost in adjusting, lubricating or cleaning bearings, and more profit through power saving. There are several types of anti-friction bearings, each with its individual task to perform, so it is a matter of economy to know which bearing will do the best job.

One type is the self-contained, self-aligning bearing. Its principal feature is its ability to adapt itself to shaft deflections. The swiveling action occurs within the bearing itself; the inner ring, together with the balls and the retainer, immediately adjusts itself within the outer ring to any movement of the shaft out of its normal axis of rotation. The self-aligning ball bearing is widely used on mine locomotive motor shafts where its shorter axial requirements permit decreased motor overall dimensions.

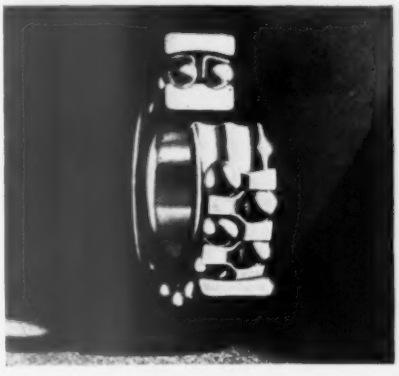
Under certain circumstances, where the necessity for alignment is not so essential, a ball bearing of the single row type may be utilized. It has deep raceways for the balls and is particularly qualified to allow for radial and thrust loads in any combination in either direction, this characteristic making it especially desirable in colliery equipment.

The spherical roller bearing is the heavy duty bearing in the anti-friction field. It is completely self-aligning and is recommended for jobs where there are extra heavy radial and thrust loads. Its barrel-shaped rollers are so designed that they will remain in permanent contact with the center flange, assuring positive roller guidance. This bearing has low frictional characteristics.

The spherical roller bearing is used in mine car wheels, and also for giant pulverizers, blowers, fans, skip hoists, screens, conveyors, crushers, drives, and loading machines.

The cylindrical roller bearing has a single row of cylindrical rollers guided by flanges on one or both races. Because of long contact surfaces between rollers and races, this bearing can stand comparatively heavy radial or shock loads and is suitable for operation at high speeds.

These are the four main anti-friction bearing types that SKF Industries, Inc., recommends to the mining industry.



From them are derived more than 1,200 types and sizes, selection from which offers a problem to the mine operator who has his eye on waste power.

Possibilities reflected in anti-friction bearing performance are greater if the right bearing is specified for the right place. An accurate knowledge of the carrying capacity is essential, for without it there can be no assurance that the bearing is the right one for its purpose.

A bearing's life is largely dependent upon the quality of bearing material and the design of the bearing itself. Yet laboratory tests have shown that even in cases where a number of bearings of the same size and type have been made of the same material and under identical conditions of heat treatment and manufacture, there is a dispersion in life when these bearings are tested on the same machine under identical conditions of load and speed.

When a group of 30 or more are tested, the average life of all bearings in this group can be determined with a consistent degree of accuracy. At the same time it is found that the lives of the bearings that first show fatigue bear a definite relationship to the average life of all the bearings.

The useful life of a bearing correctly applied and suitably lubricated is limited only by fatigue flaking of some part of the load carrying surfaces. When a bearing in ordinary application must be replaced, it is not only the price of a new bearing, but the expense of disassembling and reassembling that must be considered.

"Life" is here defined as the number of hours that at least nine out of ten bearings will run before fatigue develops in any of these parts. The average life of the 10 bearings will be five times as great.

Therefore, the life of a bearing, dependent upon its speed and load, may be expressed by this formula:

$$\text{Hour life} = \frac{(\text{factor})}{(\text{speed}) \times (\text{load})}$$

From this it can be observed that with the speed doubled, the life is reduced to one-half. With the speed reduced to one-half, the life is doubled. When the load is doubled, the life is reduced to one-eighth, and when the load is reduced to one-half, the life is increased eight times.

A small increase in bearing size, then, will result in a substantial increase in bearing life. Attention must be given to a close determination of all of the loads imposed in order to obtain the correct basis for economical bearing selection.

Methods of calculation are comparatively simple to apply so long as the forces and speeds to be considered are constant. It happens in practice, however, that both speed and the load may vary. The load may also vary in direction as well as magnitude.

In such cases, the selection of bearings may be difficult, and it becomes evident that wide practical experience is essential. In this case, bearing manufacturers are only too glad to send trained men into the field to help the manufacturer with his bearing problems.

* SKF Industries, Inc.

Picking the BRUSH for the Job

By E. A. WILLIFORD*

THE barber does not attempt to shave his patron with a scythe, nor does the farmer cut weeds with a razor. Every craftsman chooses his tools after due consideration of the nature of the task to be done and the conditions likely to be encountered in its performance. Likewise, in the selection of brushes, consideration must be given both to the performance required and to the conditions under which the brushes must operate.

On most equipment of the commutating type, ability to maintain satisfactory commutation is of primary importance in brush selection. Contact drop must be high enough to prevent excessive short-circuit current. The physical properties of the brush should be such that it will maintain firm and intimate contact with the commutator surface. The texture of stock should be of a character which will keep the commutator surface clean, well polished and free from burning. Serious lack of any one of these characteristics is likely to result in troublesome sparking.

The demands made upon a brush in service are often conflicting in character. For example, the grade giving the best commutation on a certain application may not have as long life as other grades giving less satisfactory commutation. Choice will then be directed toward the grade giving acceptable commutation and reasonable life. Total cost—commutator maintenance as well as brush replacement—should be the basis for final selection where such conflicting requirements are encountered.

On heavily loaded equipment, the current density which the brushes are required to carry may limit the field of choice. There is no suitable test for the carrying capacity of a brush since this limiting characteristic is influenced by a number of factors encountered in varying degrees on different applications. Manufacturers of brushes rate their grades as to carrying capacity on the basis of experience under operating conditions likely to be encountered in the field of application for which the brush is designed. The manufacturer's rating should not be exceeded unless, with full knowledge of the service to which the brush is to be applied, the manufacturer's representative recommends such action. Current density on commutating type equipment is determined by dividing the total machine current by the combined cross-sectional area of one-half of the brushes on the commutator.

Peripheral speed of the commutator sometimes introduces another limiting factor affecting the selection of the brush grade. The peripheral speed, in feet per minute, is determined by multiplying the diameter of the commutator, in feet, by 3.1416 and by the r.p.m. of the machine. Practically all grades of brushes in general use today are adapted to peripheral speeds as high as those encountered on the majority of motors used in mine service or on engine driven generators. The commutators of high speed motors, d. c. turbo-generators and synchronous converters, however, are frequently operated at peripheral speeds which require consideration of this factor in determining the grade of brush to be used. The manufacturer's recommendation on this point should be followed.

Abrasiveness is a characteristic to be avoided where possible for it always results in some commutator wear. On some applications, however, a degree of abrasiveness in the brush is needed to maintain a good commutator surface. A pronounced degree of abrasiveness is required only on commutators operated with flush mica and under conditions tending toward the rapid development of high mica and flat spots. The practice of undercutting the mica between commutator bars, together with the knowledge of correct methods of undercutting—cleaning out mica fins and chamfering bar edges, has practically eliminated the need for highly abrasive brushes. Even with an undercut commutator, however, the use of a brush with a mild polishing action is sometimes advantageous in preventing the spread of burning at the bar edges or the accumulation of deposit on the commutator surface. On many machines with undercut commutators a brush entirely free from abrasive characteristic will maintain a clean, well polished commutator surface, but flush mica commutators invariably require some polishing effect from the brush. An abrasive brush may prevent the development of flat spots on the commutator but cannot be depended on to remove them. Only stoning or turning of the commutator will restore a true cylindrical surface.

Abrasiveness should not be confused with hardness which is an entirely different property. Abrasiveness results from the presence, in greater or less degree, of minute particles of sufficient hardness to abrade the commutator surface. Thus, a soft brush, possessing a high percentage of gritty material, may be very abrasive while a very hard brush, free from such material may be strictly non-abrasive.

Brush manufacturers recommend the range of spring pressure within which each grade should be operated under normal conditions. A machine subject to heavy jolts or severe vibration, however, may require heavier spring pressure to maintain firm contact between brushes and commutator.

Most grades of brushes can be operated successfully, at suitable angles, in

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TYPES OF BRUSHES MOST FREQUENTLY USED ON MINE EQUIPMENT

Type of Equipment	Preferred Types of Brushes	
Field Rings	Graphite and Electro-graphitic	
Induction Motor Rings	Electro-graphitic and Metal-graphite	
Synchronous Converter Rings	Metal-graphite	
	Flush Mica	**Undercut Mica**
Commutator Type A.C. Motors	Mica should be undercut	Electro-graphitic
Fractional Horsepower Motors	Carbon	Graphite-carbon or Electro-graphitic
Industrial Motors	Carbon-graphite or Graphite-carbon	Electro-graphitic or Super-baked
Large Motors, Generators and Synchronous Converters	Carbon-graphite or Graphite-carbon	Electro-graphitic or Graphite
Mine Motors	Carbon-graphite or Graphite-carbon	Electro-graphitic, Super-baked or Graphite-carbon
Mine Locomotive Motors, Standard Voltage	Carbon-graphite or Graphite-carbon	Super-baked, Electro-graphitic or Graphite-carbon
Mine Locomotive Motors, Battery Operated	Graphite-carbon or Super-baked	Super-baked or Graphite-carbon
Welding Generators	Graphite	Electro-graphitic, Graphite or Metal-graphite

* National Carbon Co., Inc.

WIRE ROPE for Slope or Incline Haulage

By JAMES F. HOWE*

THE LAYOUT of a slope or incline haulage has a direct bearing on the results that will be obtained by the user of this system; hence, it is of vital importance to see that the original layout is worked out along lines calculated to give the best operating conditions, not only from an equipment standpoint, but also from a wire rope standpoint. Whenever it is possible to start at the beginning, it will be found highly desirable to consider the general layout and secure, as far as possible, a simplification of the operating conditions.

The principal conditions which should be considered at the outset are as follows:

1. Location of the incline or slope with respect to the receipt and delivery of mined material.
2. The profile of the incline.
3. Location of power drive and control or operating station.
4. Arrangement of knuckle sheave or sheaves.
5. Where curves are imperative, a proper arrangement of deflecting sheaves and supporting rollers.
6. Properly spaced and equipped supporting rollers along the incline.
7. Type of operation, whether a number of small cars or one large gunboat is to be handled at one trip.
8. Track support and alignment.
9. Double track versus single track and turnout.
10. Operation, whether as inside slope or as outside incline.

Let us now consider each of these points in detail:

1. *Location of Incline or Slope.*

The delivery of material at the foot of a slope or at the top of an incline should provide for easy handling and connecting the trip to the rope which is to raise the load up the slope or lower it down the incline as the case may be. Particularly if a number of small cars are used, an easy means of detaching and attaching the rope is very necessary. If a large gunboat which is always attached to the rope is used, then suitable means for easily loading the gunboat and for emptying it at the discharge end will be necessary. The kind of material handled and the general characteristics of a mine where the slope operates will largely govern the type of container or containers that may be used to carry the mine material.

2. *Profile of the Incline.*

Very often too little attention is given to this feature in the original location of an incline or slope. It is very often the case that the angle of slope or incline varies more or less from start to finish, and where this occurs, a study should be made to take care of the raising of the rope above the track that takes place when the rope pulls a load up the slope or lowers it down the incline. Whenever the rope, due to tension, is raised several feet in the air and slapped down against the supporting rollers, a very bad condition exists which will result in rapid wear on the rope, as well as make it difficult to maintain the equipment on the incline. A slight modification of the grades will eliminate this objectionable feature.

In some cases, the ropes saw through the roof of the tunnel, causing excessive wear on the ropes. Some instances occur where roof rollers are required to keep the rope from cutting through the rock, which may otherwise fall down and cause derailment along the main tunnel.

Changes in angularity of the grade should be gradual, and the original layout or profile should be selected with this point always in mind.

3. *Location of Power Drive and Control Station.*

While it is possible to bend a rope and deflect it in almost any direction, it is always true that the simplest and most direct lead that a rope can take for incline or slope service is the one that will give the best results. A number of different systems may be employed on inclines and slopes. A system frequently used on inclines is for the two ends of the rope to be attached to the loaded trip and the empty trip, respectively, and the intermediate portion of the rope wrapped around a pair of drums which are used to drive or control the speed of raising and lowering the trip. Careful calculation needs to be made where the operation of the incline depends on the friction of rope around the drums to hold the loaded trip. Enough wraps should be provided to insure against slippage which will result in accidents. Most of us are familiar with cases where the equipment is inadequate to prevent slippage at times.

When the load is pulled up a slope, it may be found advisable to have two ropes winding on and off two drums, one rope pulling out the loaded trip, and the other rope lowering the empty trip, thus working in balance and saving on power consumption. Some types of slopes, however, do not have this feature of working in balance. In such cases, the power consumption will naturally be greater than where the ropes can work in balance.

Whether one or two drums are employed, to which rope or ropes are attached, it is very advisable, wherever possible, to have these of sufficient diameter and length so that the rope can wind on in one layer. There are, of course, many cases where this has not been done, and consequently the rope has to wind on itself several layers deep on the drum. This is due either to a desire to keep down the first cost, or to a lack of space for the power drive installation. It will always be true that whenever ropes wind several layers deep on the drums, the rope service will be considerably lessened. This means corresponding increased upkeep.

The control station for the operator should be placed at a point where he can have the best possible view of the system which he is operating. This can usually be arranged, in the case of an electric drive, on an outside incline, but it is not possible to do this in the case of an inside slope. It is, therefore, customary on inside slopes to have the engine room contain the necessary markers and indicating devices to show the position of the trip at all times.

4. *Arrangement of Knuckle Sheaves.*

Many times insufficient consideration is given to this rather vital point on an incline or slope.

Assuming that drums of ample size have been provided, the knuckle sheave or sheaves should be so arranged that they will not put undue bending in the rope. If one sheave is used at the knuckle, it should be of ample size to take care of the bend of the rope at this point. If several sheaves are used, they should be so arranged that the angle of departure of the rope from each sheave is reasonable in amount, and they should be so spaced that this is accomplished. Unless this is done, it will be

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found that there is extra wear on the knuckle sheaves, and that the rope service is not as good as it would otherwise be. The angle of departure of the rope from each knuckle sheave should not exceed 4° for good service.

5. *Arrangements of Curves.*

If it were possible not to have any curves on an incline or slope, conditions would be much better. However, many cases render it imperative to have curves, particularly where mine material is being pulled out of entries at different points, and where the trip has to go into the various entries. These entries are usually at an angle with the main tunnel, and require deflecting sheaves and rollers. An inspection of systems where curves are found will indicate that in many cases rope conditions are not what they should be. In other words, it is difficult to get the rollers and deflecting sheaves properly lined up and to keep them in this manner. This is usually partly due to curves of too short radius, and partly to vertical roller arrangement.

It will be conceded by everyone that if these deflecting sheaves and rollers are not properly arranged that the rope will receive undue wear from the grinding action of flanges, or from rubbing at points where it should be deflected. Such wear decreases the rope life. Therefore, it is of vital importance to see that rollers and deflecting sheaves are kept in first class condition.

6. *Properly spaced and equipped supporting rollers.*

Rollers should be placed at regular intervals of from 20 to 50 ft. apart to support of the rope and keep it from the ties or other points where it may rub and wear itself out. The distances between the supporting rollers will depend somewhat upon the profile and the diameter of rollers which can be employed without interfering with cars which have to travel up and down the track.

It will be found that for the best service, rollers should be light in weight and equipped with bearings that will permit them to turn readily. A light roller will start up quickly without allowing the rope to slip over it, and roller bearings will permit it to turn freely and easily, which is also very essential to prevent not only wear on the rope but wear on the roller itself. In some cases, it may be found advisable to use various types of rollers, sometimes a series of sheaves mounted on a shaft where the bearing pressure of rope against the roller is light. At all events, the rollers should be long enough that the rope may be depended upon to drop into position on a roller when the trip goes by, and not deflect and go over the roller and rub on it sideways.

7. *Type of Operation.*

In mines where the main tunnel lacks headroom, usually a number of small cars will be employed, coupled together, with front end of the trip attached to the rope. In this type of operation, whenever the cars are pulled out of the mine or lowered down an incline, the rope is detached from the loaded cars and reattached to the empty cars that are pulled back to the mine. In some cases, the layout of tracks does not give proper consideration for the work of attaching or detaching ropes to handle the tonnage that is taken out of the mine. A study of this point will be productive of improved operations, and will require less manual work in performing the attaching and detaching operation.

In the case where a large gunboat is used for pulling up a mine slope, the rope is not detached, but the gunboat goes up to a dumping platform where its load is emptied and then it runs back into the mine by gravity, or is pulled to the top of the incline. When gunboats are employed, the labor of attaching and detaching ropes is entirely eliminated.

8. *Track support and alignment.*

On outside inclines, it is essential to see that track is properly supported and ballasted so that the trip in coming down the incline will not set up undue vibration of the rope or cause liability of derailment. Rails should be heavy and well fastened to ties. All that has been previously said with respect to the profile is especially true on outside inclines. Change in vertical angle of the incline should not be so acute as to pull the rope up into the air and have it bound up and down on the rollers or ties between the rollers.

9. *Double Track versus Single Track and Turnouts.*

Wherever possible, if trips are to be worked in balance, that is, loaded trip working against an unloaded trip, it will be found highly advantageous to have double tracks the entire length of the incline or slope. Whenever this cannot be done for any reason, turnouts are necessary, and these require deflecting rollers, sheaves, and supporting rollers in addition to those ordinarily used for supporting the rope, and hence result in increased wear on the rope.

10. *Location.*

An inside slope of a mine may be subject to adverse conditions in the form of mine water containing sulphur or other corrosive agents, whereas an outside incline will be subjected to exposure, rain, and snow. Good drainage of tracks is therefore essential, because if rope lies in water, corrosion is sure to take place, particularly during idle periods.

The selection of rope to be used on an incline or slope, therefore, is one that in most cases requires a close study of the conditions in order that the best possible rope may be used for installations already in use. In those cases where it is possible to establish the conditions as already enumerated and discussed, in a manner calculated to give the rope the best possible life, it will not be as difficult to select a rope that will give the best of service.

In general, for either inclines or slopes, the rope, owing to its passage over various sheaves, rollers, etc., receives more external abrasion than it would in the case of a vertical mine shaft. Therefore, rope selected and applied to an incline or slope should be one that would take into account the additional wear and meet, as far as possible, this condition in addition to the bending to which the rope is subjected. While it is possible, in some cases, to use standard 6x19 rope for inclines using ropes 1-in. diameter and larger, it will usually be found true that better service will be obtained by the use of a rope having fewer outside wires than the 6x19 construction which usually has 12 outside wires in each of the six strands. A rope constructed with 10 outside wires in each strand, or one with nine outside wires per strand, will contain larger outer wires, which will increase the ability of the rope to withstand abrasion. Along with this, consideration should be given to the strength and hardness of the material being used. It will be found in general that for incline work the grade of steel should be at least plow steel quality, and in many cases improved plow steel rope will give the best service, since the improved plow steel possesses the greatest resistance to abrasion of any of the materials used in wire rope.

We are then confronted with the question of kind of lay to be used, whether *regular* lay or *Lang* lay. It will usually be found where the incline or slope rope is attached or detached for every trip that it is preferable to use regular lay rope, because regular lay rope will not be as likely to become distorted from untwisting action due to the stretch or tension on the rope. When, however, the container or gunboat is permanently attached to the rope at all times, it will undoubtedly be found that a Lang lay rope will be preferable and give better service.

It will be possible to use some forms of Lang lay rope when the trip is attached and detached. For instance, a flattened strand rope, 6x25 construction, can be used fairly successfully even if the trip is attached or detached on each hoist; and if a preformed rope is used, Lang lay construction can also be applied to round strand ropes in a good many cases where otherwise regular lay rope would have to be used. The question then to be determined by the rope user is whether the preformed rope will give

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Modern Methods of SCREENING Bituminous Coal

By G. R. DELAMATER*

SPEAKING first of the earlier types of equipment, the shaker screen has always been, and still is, almost universally employed for separations down to and including 1¼ in. Separations below 1¼ in. have been frequently attempted with shakers, but the moisture content of freshly mined coal generally results in poor screening efficiency, and such efforts are usually soon abandoned.

There are many types of shaker screens. Some provide facilities for hand picking of the larger sizes of coal. Practically all fulfill the additional service of conveying the various sizes of coal to their respective tracks for loading. An objectionable feature is that there is little about shaker screen action to remove slack coal from the tops of large flat lumps, and considerable slack coal is frequently carried over in this manner into the lump coal car.

Revolving screens, while fulfilling the same dual purpose of conveying while screening, have been but little used in the bituminous coal industry, as they create too much breakage of the coal and permit of no hand picking.

"Modern methods" of coal screening, therefore, have to do with vibrating screens which have made possible finer mesh separations than could be undertaken with shakers and through the use of which improved screening efficiency of the intermediate sizes results.

Mechanically vibrated screens are best suited to the intermediate separations and electrically vibrated screens to the fine mesh work. Electrical screens are of two types, those with impact and those without.

In industries other than coal, separations up to and including 10-in. round hole are being successfully accomplished with mechanically vibrated screens, and there are some who feel that this type of screen can be successfully employed in bituminous coal screening up to and including 6-in. round hole. Little has been done, however, from which to draw very definite conclusions.

The first real need for equipment superior to the shaker screen came through the preparation of coal for washing and cleaning purposes. When dry cleaning was first introduced, efforts were made to screen to as small as 1/128th of an inch, but it was soon found that moisture conditions made screening below ⅛ in. practically impossible with the equipment then available, and in many instances ¼ in. was the limit.

It must be kept in mind that the bulk of the moisture present in a 1¼-in. slack coal is in the extremely fine dust, and the higher the percentage of fine dust, the higher the moisture is liable to be and the more difficult becomes the fine-mesh screening operation.

In undertaking fine-mesh screening, if the removal of the dust through the screen is inefficient, it seems but natural instinct to flatten the screen, but practical experience proves this to be exactly the wrong thing to do. The reason is that to handle satisfactory tonnage on a flat screen results in too thick a bed of coal.

The screen should be steepened to maintain a very thin bed with no possibility of packing the fines.

Any screen that throws the fine dust off the screen surface will not do efficient fine-mesh screening of coal of normal moisture content.

Probably the outstanding feature of a vibrating screen is that it causes the material on the screen surface to twist and turn continually, as it should if the widely varying shaped pieces are to find their way through the screen surface openings.

Nearly all vibrating screens attain that result, but for fine-mesh separations another need of utmost importance is to clear the screen openings to avoid blinding and to speed up screening action. Impact is the answer. Impact of great force and rapidity is impossible mechanically and is only possible electrically.

The electrically vibrated impact screen accomplishes the desired result. They may be operated at a sufficiently steep angle to assure freedom from packing; the short, rapid stroke assures the fine material hugging the screen surface, and the impact is sufficiently sharp to clear the openings.

In the coarser separations as accomplished on shaker screens, round hole punched plate has been almost universally used, but for the finer separations there are many reasons why woven wire cloth is much more satisfactory, and there is a growing tendency toward its use for the coarser separations. One of the principal reasons is the low percentage of open area of punched plate as compared with woven wire cloth.

Development of means for properly stretching and supporting woven wire cloth were essential. Loose, sagging cloth results in excessive wear on the high spots and sometimes excessive whipping of the cloth, which breaks the wires. Maximum results are only obtained where all the wires in the direction of the stretch are in equal tension and the screen surface perfectly true.

The statements made are not merely opinions, but are facts brought forth through years of experience under every conceivable condition where screening is done under normal to excessive moisture conditions.

The result has been the development of equipment which has made it possible to screen efficiently down to 10 meshes per inch at sufficient capacity to be commercially profitable and, therefore, practical. It has made efficient screening at ⅛-in., ¼-in., ⅜-in., and ½-in. possible at tonnages per square foot of screen area that were not only never before possible, but also at costs which make this part of coal preparation as practical as are the coarser separations.

Dedusting is being found profitable in many instances and for various reasons, one being to increase the fusion point of the ash in coal where it is found that this is lower in the fine dust than in the coarser sizes. It is not always necessary nor is it always desirable to remove all of the fine dust, and instances have been found where the removal of from 50 percent to 65 percent of the available minus 20-mesh dust would accomplish the desired result.

The newly developed equipment above referred to has made it possible to handle 40 tons per hour of ¼" x 0 coal containing from 3.5 percent to 5.5 percent moisture and remove from 50 percent to 65 percent of the minus 20-mesh coal, depending upon the variation of the moisture content and the atmospheric conditions. Damp, foggy weather affects the screening efficiency if tonnage feed is maintained.

It would, therefore, seem that in speaking of "Modern Coal Screening" the fact remains that for the preparation of lump and egg coal, the shaker screen is as yet the accepted equipment.

Mechanically vibrated screens are rapidly coming into use for the intermediate sizes, and the electrical high speed, short stroke impact screen has made fine-mesh coal screening a practical operation down to and including 20-mesh.

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WIRE ROPES

for Aerial Tramways

By WALTER C. RICHARDS*

AERIAL tramways, like other machines or operating systems, should be equipped with ropes designed for this service. This is particularly true of the track cables, and the locked coil cable has been designed especially for this use. This type of cable consists of from 7 to 19 round wires in the center, surrounded by one or more layers of slightly wedge-shaped block wires, and these surrounded by an outer covering of S-shaped wires. When these S-wires are laid together they form a lock, and hold each other in place. It is this outer covering of shaped wires that gives the term "locked" to this type of cable. The outer surface is perfectly smooth, and the wires are so selected and arranged that the cross-section is almost entirely metal. Cross-sections are shown below:

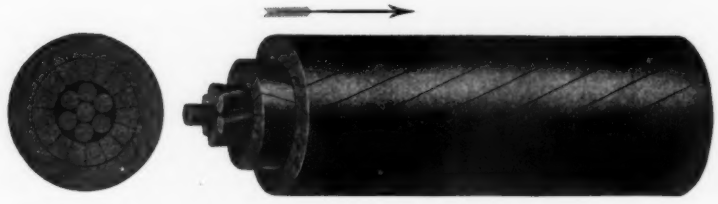
Locked Wire Rope

Locked Coil Cable

Two cuts are shown, the Locked Coil Cable and Locked Wire Rope. There is a very good reason for this designation, as it differentiates the rope used over towers and for long continuous systems from the cable used on single span tramways. These latter are practically always of the two-bucket or jigback type, and need a more flexible rope, which is secured by locked wire construction.

In installing this cable longer life is secured if the proper attention is paid to the direction in which the carriers travel in relation to the shape and position of the S-wires. The cable should be installed in such a way that the carriers will travel in the same direction in which one wire overlaps the adjacent wire.

There are three other types that lend themselves to this service: the flattened strand cable, Lang's lay round strand cable, and the so-called tramway track strand or smooth coil. Flattened strand and round strand ropes belong to that type of rope, composed of twisted strands around a hemp center, that is used throughout industry generally. To provide the maximum amount of wearing surface these cables are made of Lang's lay; that is, the wires in the strand are twisted in the same direction as the strands of the finished rope. The flattened strand is made in the Lang's lay style only, so it is not necessary to qualify this construction when referring to it, but as round strand is made more often regular lay, it must be specified as round strand Lang's lay, when intended for tramway use.



Right Direction of Travel

Flattened strand rope is the better rope to use, as the trolley wheels are not corrugated by it. This corrugating or grooving of the treads of the trolley wheels not only wears out the wheels themselves, but there is a reverse action resulting in abrasion of the rope wire, particularly when a new rope is installed that does not fit the corrugations worn by the old rope. Tramway track strand is a single strand composed of a number of wires twisted together. This gives a fairly smooth outer surface.

Tramway operators themselves can secure longer life from their track cables by seeing to it that the cables are well lubricated, and worked under the proper tension. These track cables will last longer if they are kept tight, and worked under a factor of safety of about four. When installed by a competent erector these cables are drawn up to the right working tension, and reference marks are usually placed so that the sag in the cable can be checked from time to time.

Whenever it is noted that this has increased to any great extent it is an indication that the cables are not being worked under the proper tension. When the cables are in this condition the wires are not drawn together as tightly as they should be, and there is excessive bending. The result is fatiguing of the wires, and eventual crystallization and breaking.

The proper working tension is secured by means of suspended weights, in the case of the longer tramways, or by means of blocks and falls and turnbuckles in the case of the shorter tramways. These latter types of tensioning devices are used almost exclusively on two-bucket tramways.

Tramway track cables should be well lubricated, not only to reduce the friction between the trolley wheels and the surface of the cables, but to reduce the internal friction between wires, and prevent corrosion of the wires. Tramway manufacturers always supply some type of oiler, and a good penetrating lubricant should be applied at regular intervals. If this is not done moisture will get into the rope and cause internal corrosion. It is difficult to determine when this is present, and track ropes may suddenly fail from this cause when their outward appearance is apparently all right.

The proper rope should also be selected for the traction rope on aerial tramways. The rope should be fairly flexible, and at the same time should have wires on the outside of sufficient diameter to stand considerable abrasion. Traction ropes of small diameter are made with six strands of seven wires each, and the larger ones six strands of nineteen wires each, made Seale construction. These ropes should also be made Lang's lay, but as they are both of the round strand construction they may eventually corrugate the tower rollers and terminal sheaves if the unit pressure is very great. On the larger tramways it is, therefore, desirable sometimes to use a flattened strand traction rope.

* Engineer, A. Leschen & Sons Rope Co.

CONVEYOR Mining

By C. R. CLAGHORN*

IT IS perhaps not generally known that the first installation of Mining Conveyors was made in Central Pennsylvania in 1901, where a number of hand loaded Chain Conveyors were used on 250-ft. Longwall faces, as a means of transporting the face coal to a convenient car loading point, thus furnishing facilities for the rapid stripping of the faces, as well as reducing the amount of pack walling then customarily used when cars were brought directly to the faces. This involved a radical departure from the well established American Room and Pillar system.

However, the main factors involved in the plan were communicated to England, where Longwall was, and is, the popular system. To install conveyors on already existing Longwall faces required relatively little change in methods, so the use of sectional conveyors became extensive and spread to Germany and other continental countries, first, for face work and then, as types of conveyors were improved through experience, to the gate roads, displacing the use of cars to within a considerable distance from the faces.

These conveyors were made sectional for rapid assembly in the mine and in changing locations. On the faces, they were made sectional, because, the face timbering precluded the moving forward of the face conveyors as units, so that they could be knocked down into small parts, threaded or flitted through timber and reset for operation, with each successive face cut.

During the past 10 years, Mining Conveyors have gradually been growing in popularity in the United States.

Mining Conveyors, at this time, may be considered primarily as "Medium of Transportation" since they are either "hand loaded" or fed by some mechanical loading device.

The simplest form of room outfit consists essentially of two units, a low face conveyor that can be quickly and easily advanced, and a room conveyor that can be rapidly extended as the face advances. The face conveyor feeds the room conveyor which, in turn, discharges into mine cars, coupled together in a trip, on the heading. The cars pass under the discharge end of the conveyor. In this simple single room type, to avoid car congestion (empties and loads) between adjoining rooms, the rooms must be kept far apart with but little concentration.

A more advanced system, now practicable with modern equipment, provides for the discharge of the room conveyors to a simple "gathering" unit of sufficiently large capacity to receive simultaneously from all the rooms in the panel and discharge in turn, to trips of cars, at a more permanent point. This naturally gives the maximum of concentration of work within a limited area, which results in large indirect operating savings.

In room work the face conveyor plays an important part in the general scheme. If properly designed it has very low sides, giving minimum "lift" for the shoveler or loader, who barely lifts the shovel. It would be like shoveling into a hole. There is little tiring back work and when the face conveyor is properly placed there is the least expenditure of "foot pounds" of energy. Naturally this speeds up the work of loading. As the face conveyor spans the face, there is no double shoveling from far corners, which also speeds up loading. Large lumps are more easily rolled onto a low conveyor than when lifted over the side of a car, resulting in less degradation at the faces, less effort and faster loading. Finally there is no waiting for cars, as in the usual direct car loading, since the coal is actually discharged into cars in trips on the entry by the room or gathering conveyor.

The facilities enumerated above result in a face crew being able to complete a cycle of cutting, shooting and loading a room face several times each shift.

In addition to the room outfit of face and room conveyors, with necessary drilling and blasting tools, it has been found advantageous to stable a Shortwall Undercutting machine in each place so that the face crew is entirely self contained and by working each place double or treble shifts, a fair return in tonnage is secured for the investment.

Since, at present, the largest proportion of coal is hand loaded, it can be shot to produce the best commercial results in the matter of profitable sizes.

As already remarked, Mining Conveyors have been mostly applied without radical changes in the mining plans. Wide rooms are an advantage but not always a necessity. Rapid extension of narrow work permits the driving of narrow rooms and the extraction of pillars retreating, should such a system be found advantageous. This rapid exploitation results in improved roof conditions and greater safety. No doubt wider experience with Mining Conveyors and further development of improved types will result in modifications of the customary room system with lower cost and increased safety. The mining of large tonnages by groups of conveyors, within relatively small areas, permits intensive supervision of all activities including that of safety.

The long and wide use of Mining Conveyors abroad has enabled the British and continental engineers to set a standard of excellence of conveyor equipments, which American engineers will further develop to suit the needs of American mining practice. Published government figures state that over 8,000 conveyors were in use in Britain at the end of 1933. Probably as many more were in use in Germany and other continental coal mining countries. Manufacturers report great activities at their plants despite the world depression.

As coal owners get a better understanding of and have more confidence in Mining Conveyors and as manufacturers further develop their equipment, rooms will be driven 400 and 500 ft. long, greatly reducing investment in plant and overhead in operating.

Many engineers believe that underground belt conveying, despite the great progress already made, is still subject to great improvement. Driving heads will, no doubt, be so perfected that little or no tension for driving traction will be required and belting will be tensioned only to eliminate "slack," (i. e. sag between idler rollers) resulting in longer belt life. Idler designs will be improved so that "troughed belts" will have the same "stability" and be as "fool proof" as "flat belts" and combine the useful and valuable advantages of the two types, thereby quieting the controversy as to the relative merits of the two styles.

Long distance belt conveying, in a single unit, underground and on the surface, will be a development of the near future—normal tonnage, any distance, under ordinary conditions. This development, radical as it may seem, now is under consideration and will hasten the fulfilment of the Mining Conveyor engineer's dream of an "all conveyor mine."

* Conveyor Engineer, Goodman Mfg. Co.

ROLLER BEARINGS

Cut Production Costs

By E. C. REITHER*

IN ANCIENT days men carried all loads on their backs. Then came sleds, hauled by men or animals. The invention of the wheel was a tremendous advance. However, costs were not figured in the same way in the past as they are under present day conditions, and the day when plain bearings were good enough for mine cars, locomotives, conveyors, etc., has likewise passed, just as the mule has been replaced by the mine locomotive. Anti-friction bearings, which decrease costs, increase efficiency, and reduce maintenance, have revolutionized the industry.

Many factors must be considered in selecting mine equipment. This applies to mine cars, locomotives, loaders, and conveyors, used underground, with particular emphasis, and in such equipment no single item is more important than the bearings. Bearings must stand up under the most severe service, be able to get along with a minimum of attention, withstand shocks, high speeds, and overloading, and still operate easily in both wet and dry mines with long or short hauls at any speed.

As hauling is one of the major items of expense in a mine, it is interesting to note how the use of anti-friction bearings reduces hauling costs. Friction is reduced to a negligible quantity, and as a result mine locomotives can haul longer trains, men can move heavily loaded care more easily, and lubrication costs are greatly reduced. At the same time, wheel replacement charges are much lower, as the hub cannot wear and wheel life is determined by the slow wear of the treads. Flange wear is reduced to a minimum because the wheels are permanently kept in alignment by these bearings, which carry both radial and thrust loads without constant attention. Also, track and car maintenance is similarly reduced.

The figures shown in Table I are based on a survey made by the A. C. Neilson Co. in a West Virginia mine and show clearly how the use of anti-friction bearings reduced the cost of hauling. The amount of coal which could be hauled per train, and easily, was increased 20 percent. Car lubrication costs were reduced 86.9 percent. Track maintenance was eliminated, and while exact figures could not be secured, the management stated that power consumption was materially reduced. This was evidenced by the fact that it was formerly impossible to accelerate more than one 25-car train at a time. Now two 30-car trains can be accelerated simultaneously without tripping the circuit breakers. Also, a motor which formerly had trouble in handling 30 cars can now pull 60 cars easily.

TABLE I

	Plain Bearings	Timken Bearings
Cars per train, average	25	30
Tons per train	96.5 t.	115.8 t.
Costs per train:		
Fixed charges	$2.83	$3.02
Lubrication	.33	.05
Car maintenance	1.53	.29
Track maintenance	.32	...
Crew labor	1.20	1.20
Totals, less power	$6.21	$4.56
Cost per ton	$0.064	$0.039
Saving per ton	....	.025=39%
Cost per ton mile	$0.021	$0.013
Total annual saving		$21,125.00
Return on added investment		37.8%

Another well known mine hauls from 30 to 50 loaded cars per trip, about 10,000 feet of the haul being down a 3 percent grade where they have to use shoes under the wheels for braking purposes. Excessive side thrust is developed on this haul, each car holding 4½ tons of coal, yet the company finds that they only have to adjust the bearings under their cars about once every three years.

The application of anti-friction bearings to mine locomotives is equally effective in keeping costs down. In this case the saving comes in reducing operating and power costs, for roller bearing mounted locomotives operate more smoothly and easily. Next must be considered the reduction in lubrication costs. And possibly the most important saving is the reduction in repair and maintenance charges. When gears and pinions wear as the result of looseness and misalignment in the axle journals, difficulty is experienced with the armatures of the motors and windings may be damaged.

Mine ventilation is a particularly important item in mine operation, and there again the value of anti-friction bearings is clearly shown. One company, for example, made a saving of $552 a month by changing from an old fan 16 ft. by 5 ft. to a modern unit 8 ft. by 4½ ft. The fan manufacturer reports that about 15 percent of the efficiency shown by the new installation is due to the use of the anti-friction bearings, the overall unit of efficiency being 78.1 percent, which is outstanding.

Figures like these could be extended almost indefinitely, but those given will serve to show that in every instance the application of anti-friction bearings to mine equipment from the working face on through the whole plant will reduce costs, increase efficiency, reduce maintenance, improve working conditions, and keep equipment in service longer and with less attention. Anti-friction bearings are as much a part of modern mine equipment as are modern explosives and mechanical aids of all kinds.

A test by a large Pennsylvania operator showed that it cost only 33.20 cents per car per year to keep 3,560, 52-cu.-ft.-capacity mine cars well lubricated. Other tests have indicated that lubrication for plain bearing cars cost over $2.00 per year. Many mines find that Timken-equipped mine cars require greasing only once a year, basing their statements on fleets of from 500 to 5,000 cars in service.

* Manager, Mine Car Division, The Timken Roller Bearing Company.

Electric Welding and Alloys in MINE CARS

By CHESTER G. SENSENICH*

STRENGTH, increased capacity and longer life in mine cars—without increase of the tare weight—have been the objective of many coal operators and mine car manufacturers in the past few years. Two developments of the utmost significance—electric welding and the use of rust-resisting alloys—have brought about the attainment of this objective.

Electric welding in recent years has made rapid strides and advancements. By the use of electric welding, improvement in design has been accomplished, the actual tare weight of the car has been reduced and the capacity increased. Electric welding permits many short cuts in design.

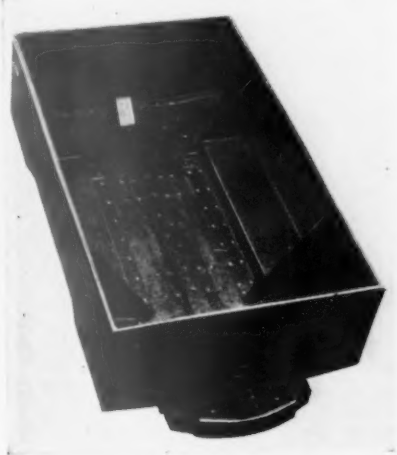
One of the most important features in welding is the type of wire used. The coated welding wire, or coated electrode, is one of the leading developments in the welding industry. The coating on the wire melts more slowly than the wire itself and thus forms a protecting sheath or crucible at the end of the electrode. In this manner, the hot metal does not come directly in contact with the air. The coating forms a protective slag on the weld and thereby reduces the rate of cooling. A fusion of the metals is the result, rather than the casting of one metal between two other sections of metal to be joined. The ultimate strength and the elongation are increased and the Brinnel is decreased.

Another important consideration, not so well understood, is the impact value. The impact value of the weld made by the ordinary bare rod is comparatively low, while the weld of the shielded rod is, approximately, 10 to 15 times greater. This is a substantial factor in the construction of mine cars, as they are subject to shock and hard usage.

It has been found that bare electrode welding is not suitable for the longitudinal seams on which the longitudinal stresses are of any great magnitude. Also, that with a coated electrode giving deposits having an elongation in two inches of 20 percent, or more, and of ultimate tensile strength of 65,000 pounds per square inch, or more, suitable joints can be made having a longitudinal efficiency and elongation of a type superior to any riveted or bare electrode joints now in use.

In continuous lap welding in mine car construction, every joint is sealed. Moisture is prevented from collecting between such joints to start its damaging effects, thereby guaranteeing longer life and better service in mine cars.

Welded construction permits placing metal to the best advantage and where it is most needed. Every design problem consists of specific and limiting dimensions of proposed mine cars. This problem may be divided into numerous items. The first step is the determination of the most suitable and practical material. Consideration must be given to the selection of the material and how



the material influences size, shape, weight, cost of production and operating and maintenance costs.

A specific example of the great possibilities of welded construction is provided by an order of mine cars recently built for the Allegheny Pittsburgh Coal Company, an affiliated company of the West Penn System. The original mine cars of riveted type construction had a capacity of approximately three and one-half tons, and a tare weight of 4,000 pounds. With the same overall dimensions and by utilizing welded construction, the capacity of the car was increased to approximately five tons, while decreasing the tare weight to 3,550 pounds. While extreme care was taken in the design of the car, considerable thought was given to the type of metal that should be used in the construction.

The most dangerous enemies of steel mine car construction are rust and corrosion. They revert ferrous materials to their former state, that is, iron oxide. Authorities have lately estimated that the world's total annual loss of iron and steel from rust and corrosion approximates one and one-half billion dollars, equivalent to almost one-half of the normal annual production of steel in the United States. Due to the severe corrosive conditions existing in coal mines, much thought has been given to the use of ferrous alloys in mine cars.

The problem encountered was a double one: first to find a suitable metal with high rust and corrosion-resistance qualities: second, and of almost equal importance, a metal that would not be prohibitive in cost. Pure elemental iron in itself is of practically no value. A proper choice of alloys and a control of the impurity content represent the difference between desired permanence and an undesired rapid deterioration.

The addition of copper in making both iron and steel has become an established method in sheet metal production. Copper, when added to a well-made open hearth iron, is a means of obtaining the maximum resistance to rust and corrosion. The addition of molybdenum not only adds to the corrosion-resistance but gives iron and steel increased tensile strength. This alloy in itself is of great benefit to mine car construction, as it imparts additional power to withstand shock and impact stresses.

In the cold fabrication of every mine car, the many cold worked areas which result are the points of weakness of the car, in that these cold worked areas are more susceptible to corrosive attack than the unworked areas. Discouraging experiences in steel cars tell us that these cold worked areas are partially responsible for the rapid deterioration of the average mine car.

Toncan Iron is of practically the same weight as that of ordinary iron and steel; hence, there is no advantage in its weight structure. But, with its high resistance to rust and corrosion, it maintains its original weight and thus its full tensile strength for a greater length of time. It is quite important that the type of wire used be of the same chemical analysis as that of the metal used in the construction of the mine car. In this manner, no part of the car is more susceptible to rust or corrosion than any other part.

* Vice President, Irwin Foundry & Mine Car Company, Irwin, Pa.

Development of BLACK BLASTING POWDER For Coal Mining

By JOHN L. ROMIG*

THE development of black powder for peace time use did not take place until some time during the early part of the seventeenth century. It is claimed that in 1613 Martin Weigel first used powder for blasting in a mine at Freiburg, Saxony. Towards the end of the seventeenth century black powder was first used for road building to widen a road at Albula in Switzerland. It is only during the past century that black powder became important in commercial projects.

Modern methods have had a tremendous influence on the development of explosives. To meet the demands of modern mining, dynamite formulae have been developed to give greater efficiency and less harmful fumes. In this group of explosives we have the "permissibles" which were primarily formulated for gassy and dusty coal mines.

From black blasting powder, pellet and blakstix have been developed. Pellet powder has been in use in this country for approximately 15 years, and blakstix for four years. In certain seams of coal the slow rate of combustion of stick powder has been found favorable for the production of coarse lump coal.

Pellet powder, which is the first developed of the so-called stick powder, is the result of pressing grain powder into pellets 2 ins. in length, each having a central hole throughout its length, and wrapping four of these pellets in an 8-in. cartridge. The acceptance of this powder in nonpermissible mines was quite general.

Tests for determining the time of burning and rate of pressure development may be made by means of the Bichel gauge, to which some special equipment has been added. From the curves recorded during the tests, calculations can readily be made to indicate rate of burning, maximum pounds pressure per square inch; also the maximum rate of pressure development per second. By suitable methods, moisture and specific gravity determinations are made.

There are a number of practices that should be discouraged when black powder is used, such as the removal of the paper from the ends of the cartridge and the paper shell from the powder. The introduction of this type of powder was primarily for the purpose of providing greater safety as compared to grain powder. The removal of the protective paper covering offers an unnecessary hazard. This being especially true in an open light mine. Furthermore, the powder is left without any protection from moisture. The absorption of slight amounts of moisture readily affects the efficiency and increases the amount and type of smoke.

Occasionally miners use their tamping sticks to crush the powder. This practice defeats the advantage claimed for stick powder blasting. The result is that the crushed stick is broken into many different sized particles and dust. From this practice the powder in one bore hole may be coarse throughout, whereas that in the next hole may be fine throughout. This condition results in different action on the coal. An example for comparison would be loading one hole with 4-F grain powder and another with 2-F grain powder in the same coal face. Aside from this, there are a number of accidents on record showing that the practice of breaking up stick powder sometimes causes sufficient powder dust to be forced from the bore hole, and to be ignited by the miner's open light, thus resulting in an explosion.

The central opening in the stick powder provides a means of having the ignition flash pass through the entire length of the charge instantly. This permits having the pressure built up with a greater degree of uniformity than is the case where the flash must burn progressively through a tightly packed charge as with crushed stick powder. When the entire charge is ignited along the central perforation, it is thought that greater efficiency in combustion and execution result. The more complete the combustion, the less the smoke and the fumes that are given off. It has been found experimentally that the paper wads covering the ends offer no measurable resistance to the flash passing through the central opening in the cartridge.

Direct ignition, which means placing the electric squib or electric detonator in the last cartridge placed into the bore hole with the loaded end of the detonator pointed towards the bulk of the charge, is recommended from a safety point of view. The type of ignition has an effect on the rate of burning. Tests with a single cartridge have shown there is an appreciable difference between the rate of burning established by a miner's squib and an electric squib, the latter giving a shorter period of burning, which has the result of producing a more effective pressure. The difference between electric squibs and electric blasting caps is slightly in favor of the electric blasting caps.

The action of stick powder is dependent on the degree of confinement. The material used to obtain confinement governs the effectiveness. A publication from England's Bureau of Mines relative to stemming lists sand, or a sand and clay mixture, as the most effective. In order to keep smoke and fumes at a minimum, it is necessary to give attention to thorough confinement, since this also reflects directly on the type of execution.

The storage facilities for powder in the mine should provide protection from the action of moisture. Actual tests have shown that any explosive having a high ammonium or sodium nitrate content is very susceptible to the action of moisture. Moisture will greatly reduce the effectiveness of an explosive within 24 to 48 hours if the seal provided by the cartridge is disturbed. Cut cartridges can be protected by placing some type of seal over the open end. A tight box similar to a tool box is recommended for the underground storage of powder.

Black powder cannot be used in mines which require a permissible type of explosive. It is to be remembered that the volume and duration of the flash from these two powders are very much outside of the limits for permissibility. In mines which are very gassy or dusty only permissible powder should be used.

* Technical Representative Atlas Powder Co.

Reducing Coal-Mine TRANSPORTATION Costs

By G. E. STRINGFELLOW*

IN coal-mine transportation, particularly when mechanical loading of pit cars is employed, each step in the movement from face to tipple is dependent upon the preceding one. Failure of any link in the chain slows up and finally stops production with a decrease in tonnage per day and an increase in cost per ton.

Continuous transportation is certainly one of the essentials of low-cost mining; and therein lies what is perhaps the greatest single contribution of the nickel-iron-alkaline type of storage battery to coal-mine transportation. As the source of motive power for the gathering motor, especially under mechanical loading, the storage battery has been placed in a position where its dependability or lack of it has a direct and immediate effect on the daily coal production.

A loading machine can load a pit car in little more than a minute so that, except for the normally short time necessary to relocate it for the next load, its daily production depends on the speed and regularity with which the gathering motor is able to switch the loaded car to the relay point and return with an empty. That it should be absolutely reliable and not subject to failure of any kind are axiomatic.

From the standpoint of the storage battery, mine locomotive service is severe not only because the duty is heavy, but also because it is seldom possible to operate and maintain the battery under what might be termed optimum or "laboratory" conditions due to the routine which the locomotive must necessarily observe.

The battery must be able to withstand mechanical shock and at times to accept a charge at boosting rates. It can not always be recharged immediately, nor can its discharge always be terminated at the same ampere-hour output. These are some of the conditions under which it must work in practical mine service. If unable to deliver sustained capacity under these conditions, unnecessary failure of the gathering motor is inevitable.

Mine haulage surveys show that the nickel-iron-alkaline battery's superior ability to operate dependably under these practical conditions improves the continuity of gathering and relay motor operation to such an extent as to increase the daily production of coal as much as 17 percent *with the same loading and transportation equipment and with the same man-hours of labor.*

The significance of this accomplishment in terms of the earning power of the mine is readily apparent. In one case studied, it was shown that a production increase of only 5 percent would raise the annual net profits of the mine by an amount *over four times the total annual operating costs of all storage batteries in use.*

In addition to these calculable earnings of more dependable motor batteries, a great many intangible factors are introduced which result in improved mine operation.

For example, under completely mechanized mining, a considerable amount of supervision is required. The use of long-lived, dependable batteries eliminates the need for continually shifting locomotives from one operation to another in order to adapt varying battery capacities to the individual jobs. The labor and time required for replacing batteries are also very substantially reduced.

As a result, the electrical department of the mine is free to devote its attention to other problems which have a more legitimate claim upon it.

Experience shows that greater dependability reduces the operating cost of the battery itself. But even if the operating cost were increased the maximum possible battery dependability would still be an economy because of its potent influence on profitable operation of the mine as a whole.

* Thos. A. Edison Company.

Choosing the Proper Rail Bond

(*Continued from page* 36)

average current value at which it becomes economical to use the larger size of bond.

Let us illustrate by an example: Take a 4/0, 24-in., and a 2/0, 22-in. steel arc weld type of bond. Based on average labor and power costs, the following installed resistance values, bond costs, and installation costs are arrived at.

Size of Bond	Installed Resistance Ohms	Cost of Bond and Rod	Total Installed Cost
4/0 24-in.....	.000125	$.676	$1.213
2/0 22-in.....	.000175	.484	.974
Difference	.000050	.192	.239

It will be noted that an additional cost of 24 cents is encountered in order to save 50 microhms resistance per joint. Now, if we assume a 10-year average life of the bond, an interest rate of 6 percent on the invested money, a power cost of 1½ cents per kilowatt-hour, and an operating period of 3,600 hours per year, we find that the current per rail necessary to justify the 4/0 bond must be 109 amperes or a total of 218 amperes per track. These current values of course are average values (r.m.s.) over the operating period and are not comparable in any way with the 15-minute peak values often experienced.

Since our experience indicates that the load factor in most coal mines operating cutting machines, pumps, haulage and gathering motors, etc., is usually around 30 to 35 percent of the connected horsepower, the above figure indicates that the present or contemplated connected load in a given section of a mine must reach 165 hp. before the 4/0 bond can be economically used in preference to the 2/0 bond. By the same method of calculation we find the connected load in a given section must reach 330 hp. before two 4/0, 24-in. bonds can be economically used per joint. With shorter operating hours or with lower power costs than those specified above the r.m.s. current values and connected horsepower must be still greater than those calculated above.

Donald Jay Doan, who received the degree of Doctor of Philosophy at the University of Missouri this spring for work done in the field of metallurgy at the School of Mines and Metallurgy, has accepted the position of research physicist with the Eagle-Picher Lead Company at Joplin, Missouri.

Modern Main Line HAULAGE Locomotive For Coal and Metal Mines

By G. H. SHAPTER*

THE modern main line haulage locomotive must be rugged, speedy and powerful in order to meet the present-day requirements for large output, long distances and continuity of operation as now demanded in the mines of the various coal companies. Particularly in coal mining by process of consolidations of small groups of mines into one operation, and by extensive development of individual mines, the operators now present a problem to the manufacturer which challenges their ingenuity to the limit. It is not uncommon to encounter such operating conditions as a haulage distance of five to seven miles from the face to the tipple, or shaft bottom, track profiles of 2 percent to 4 percent against heavy loads, narrow entries, and long trips of mining cars as many as 100 to 125 in one string, holding from 500 to 600 tons of coal.

We wish to set forth primarily in this brief article a statement on the essential parts of the modern design of mining locomotives.

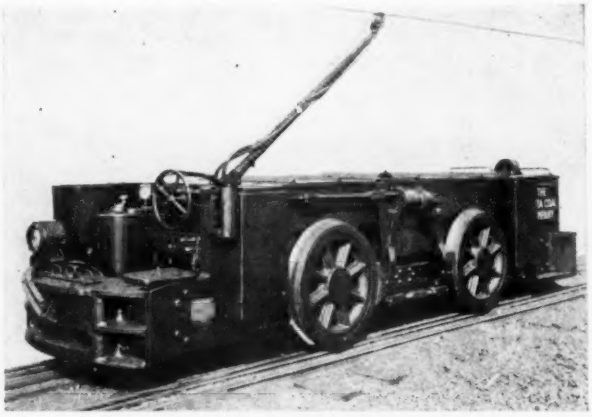
First, and probably of the greatest importance is the motor equipment. Motors must be of liberal and sturdy construction, easy to inspect, maintain and repair, and as free from troubles as design limitations permit. They must have high capacity for continuous heavy loading and for extraordinary heavy duty. The heating capacity should always be figured so as to meet the requuirements of the operating cycle. The manufacturer of the locomotive and motors should be given the opportunity of calculating the requirements of extraordinary heavy haulage conditions, as by this means the operator will be sure of obtaining satisfactory motor performance.

Occasionally the operator may be in position to know what size of locomotive and what capacity motor equipment are needed for a given application by reason of the fact that he may have had in service locomotives of similar character which would enable him to judge whether or not the new equipment was adequate for the contemplated service. More often the operator is not in position to make this comparison and therefore the manufacturer should be given a track profile, the expected tonnage output, the weights of cars, both loaded and empty, and the expected number of cars per trip. He will then be in position to offer the operator the best recommendations, and at the same time be sure that he himself is applying an equipment which will give long service, the least maintenance, and produce the greatest output of coal with the least expenditure of money.

The heating of traction motors on mining equipment should be figured so that the temperature rise after an all-day run is well below 75 deg. C., and if this is accomplished, it should not be necessary to re-wind the traction motors every year or less, as is very often the case. In fact, a good job of application should show a result where motor rewindings would not be more frequent than every five years, and perhaps ten years is not unreasonable to expect. It is obvious, of course, that no manufacturer could make such a guarantee to any user, as the manufacturer cannot be certain that all the facts have been given to him accurately, or that when the installation is placed in service the conditions will not exceed those stated in the proposition.

It can be shown by calculation that where haulage distances exceed approximately one mile, the motors should be separately ventilated by forced draft derived from an external motor driven blower. Otherwise if the locomotive makes continuous trips one immediately following the other, with the usual short-time delay at each end of the trip for changing trains, the motors will overheat, and frequently re-winding will be necessary. Hence the modern trend of design points to separate ventilation of traction motors and more and more of such designs are being produced today to the great satisfaction of the users.

Ten or fifteen years ago it was common practice to specify a motor equipment equal to 10 hp. per ton of locomotive weight, then later 12 hp. per ton of locomotive weight, and still later 15 hp. per ton of locomotive weight, all because by experience the operator knew that the next time he should have bigger motors. Why? Simply because the previous ones were too small and had to be re-wound frequently, so by deduction the operator concluded that larger capacity motors were needed and, of course, that was no doubt a good solution. However, it is not possible to continue increasing the one-hour rated horsepower capacity because the motors themselves become heavier as they become larger, and the weight of the locomotive itself necessarily increases until there comes a time when it is no longer possible to increase the horsepower per ton of locomotive weight except by sacrifice of mechanical strength of the locomotive.



Type LME-2C20-B Industrial Locomotive

Horsepower capacities are based on the one hour totally enclosed basis for 75 deg. C. rise, and this merely serves as a guide for comparison of competitive equipment; whereas this one-hour rating of a motor does not in any way reflect its ability to perform a given haulage service. For short hauls where it is not possible to load the motor for any continuous length of time greater than 10 or 15 minutes perhaps, the one-hour rating of the motor may be significant to determine its suitability; but when the haulage distances become long, it is necessary to consider not only the one-hour rating of the motor, but also its continuous rating, and make careful calculations as to heat losses for every load condition which may come on the motor.

* General Electric Co.

By evaluating these properly, the manufacturer is in a position to apply the proper motor equipment.

A traction motor with high one-hour rating, indicating an ample amount of copper in the armature winding, may be greatly improved in capacity by the circulation of air through its interior, and it is possible by using sufficient air to make the continuous rating almost equal to the one-hour rating. This is an extreme case and is not very often necessary in mining work. Probably an increase in capacity of 50 percent over the closed continuous rating would meet even the most severe hauling conditions.

The modern haulage traction motor should have solid gears pressed on and keyed securely to the axle. The gear should be of the best quality forged steel heat treated for homogeneous tooth structure and hardness. Cast gears, split gears and excessively hardened gears are troublesome and require frequent replacements.

The motors should have, where possible, dust and dirt-proof axle bearings, preventing dirt, sand and other foreign matter from entering between the lining and the axle. Such linings have been furnished, and some have been in service as long as five years before needing replacement; whereas the old type of lining would require in some services replacement probably every six to nine months. Anti-friction axle bearings have been used for the same purpose because they necessarily have to be sealed, else ruined; they, too, give good long service. However, on account of the large axle diameter and the consequent large bearing sizes, the bearings applied to axle mountings are unnecessarily over-size, and hence this type of assembly on a motor proves excessively costly and seemingly unwarranted, when less expensive and equally serviceable bearings are available.

Motor magnet frames are most generally split with top and bottom halves held together by heavy through bolts. The upper and lower half clamping the armature bearing heads firmly between them, and means should be afforded for holding the armature head from turning, which can be accomplished by anchor lugs and bolts or other mechanical device.

The modern mine traction motor is of the commutating pole type, affording excellent commutation at extremely heavy overload current. The armature bearings are of the anti-friction type, which has proven to be very beneficial in regard to saving burned-out armatures previously caused by armatures dropping on pole pieces.

Modern control for heavy duty haulage is of the contractor type, consisting of several individual contractors opening and closing the main circuits, and commutating the resistance or accelerating steps. Previous drum type controllers are no longer used above 8-ton locomotive size, as such controllers are physically hard to operate, expensive to maintain and difficult to service. Also the large drum controllers occupy too much valuable space in the operator's cab. On the contrary, a master controller is small in size, affords maximum room in the operator's cab, handles only a small current required by the magnetic contactors, usually in the order of ½ to 1 ampere per contactor. The contactors themselves are of scientific design with arc chutes so made as to quickly suppress the interrupting arc; they have rugged renewable contacts, and the entire contactor group can be advantageously disposed in the locomotive to the best advantage as to space occupied.

One of the important parts of modern control is the traction motor resistor, which is now of the continuous ribbon type, made of special alloy steel, capable of operating at cherry-red heat without damage or breakage. Such resistors as the General Electric EW type represent probably one of the greatest improvements of locomotive construction in recent years.

Locomotive frame structures have been improved greatly as to strength, accessibility, and greater attention has been given to proper balance, distribution of weight on the axles, proper wheel base, flexibility of spring mounting and track stability. Vast improvements have been made in the method of wiring the mining locomotive which in years gone by consisted merely of a bunch of wires taped together and strung anywhere in the locomotive where space could be found, but now suitable conduits machined into the framework of the locomotive where individual wires may be laid and protected by a cover in such a way that they are easily accessible for replacement and repair, and further are so placed as to be more or less out of the way so that they are not so frequently damaged that re-wiring of the locomotive becomes necessary.

The modern mining locomotive is equipped with anti-friction journal bearings, which are rapidly superseding the former oil and waste packed type of bearing. The advantages of the anti-friction bearing are so great as to quickly wipe out the extra first cost which they entail.

Thus the modern main line mining locomotive has kept well ahead of the severe service requirements now encountered.

The accompanying illustration shows a modern 20-ton, 500-volt outside wheel haulage locomotive, which is equipped with two 125 hp. one-hour rated motors, having forced ventilation, straight air brakes, and the locomotive will develop tractive effort of 10,000 lbs. at a speed of 10 miles per hour. Two such locomotives are now operating in tandem as a 40-ton locomotive, hauling 125 to 140 cars per trip for a distance of five miles on a track profile having grades up to 2½ percent. Dynamic braking is also used on this tandem equipment.

Preparing Coal of Higher B.t.u. Value

(*Continued from page* 30)

ery parts should be slow-moving. Good light, and absolute prevention of dust should be given due consideration, a clean plant being a great aid to reliability of both machinery and cleaning results.

Breakage must be kept down to its absolute minimum as coal passes through the plant, for breakage means loss of revenue. Amongst other things, appearance of cleaned product must also have consideration. Having touched lightly upon the general requirements of a cleaning plant, it may be suitable to give a few of the essential items for efficient handling at low cost:

(1) Easy supervision.

(2) Simple adjustment—without interrupting the operation of the plant.

(3) Cleanest coal practicable to produce.

(4) Minimum loss of coal with the refuse.

(5) Minimum consumption of power.

(6) Small consumption or loss of water.

(7) Adequate treatment of the fine coal.

(8) Small liquid effluent.

(9) Good sizing of cleaned product—only possible by screening after washing.

(10) Good appearance of cleaned coal.

(11) Minimum breakage.

(12) Ability to work satisfactorily with good results, under the varied conditions arising at the mine.

The Wash Box

The principle of operation is similar to that of the plunger jig system, but the pulsating medium in the wash box is compressed air, under such accurate control that it avoids all "back suction," and loss of good coal through the bed; allows any necessary adjustment to be made without stopping the plant; discards heavy dirt immediately after it enters the box, thus preventing any possibility of pounding; permits washing all sizes of coal collectively in one box, in capacities up to 200 tons per hour and over, and dispenses with presizing and degradation with its attendant dust nuisance; allows graduated pulsations in the different compartments, with a consequently more complete separation; has less moving parts; gives easy and accurate control of all processes, and furnishes uniformly clean coal to the screens for final sizing.

The "Electric Eye," "Auto Constant" Refuse Control is used on the Link-Belt Simon-Carves Washing System. It automatically and constantly regulates the removal of rejects from the wash box. The photo-electric relay principle is used, combined with a non-counterweighted float, which is as sensitive and free in its movement as a hydrometer. It positively distinguishes between the specific gravities of coal and bone, or slate.

Efficient Methods of CUTTING Out Slate Partings

By L. F. CRAWFORD*

AT THE present time, slate partings are removed from seams of coal by one of several types of mining machines, equipped with a cutter bar and a cutter chain of the conventional block and strap type.

In some instances, these partings may be readily cut, but often they are too hard or contain so much abrasive material that the use of steel bits is impractical. However, they may be successfully removed by a method which will be described later.

The prevailing types of cutting machines now in use for this work are the Shortwall and Track Mounted machines.

The Shortwall machine is used almost exclusively where the seams of coal are thin and have the partings either near the top or over the coal.

The Track Mounted machine is used both for thin seams where the partings are near the bottom, near the top or over the coal. They are also used for thick coal where the partings are located at any height in the seam.

In most seams of thick coal in the United States, there are slate partings. However, the low production costs make mining of these seams profitable, especially since the development and perfection of methods to mechanically clean the coal.

With efficient methods of cutting out the slate partings, not only is a large part of the cost of cutting absorbed but a further saving is made by either eliminating wholly or in part this cost of cleaning mechanically. The construction of track mounted machines to meet all of the varying conditions of this class of work is covered by four general types of machines. These are:

1. A machine which will raise or lower and also tilt the cutter bar an amount sufficient to cover the range of variations of the slate parting from the bottom. This machine may be so built that one kerf may be cut ranging from 3 to 12 in. thick. The cuttings drop to the mine bottom and are then loaded back or into the mine car by hand.

2. A machine which will raise and lower and tilt the cutter bar sufficiently to cover all the range of variations of the slate parting from the bottom, the cutting element built to cut out kerfs of a range up to 15 in. in thickness in one operation. These cuttings instead of falling to the mine bottom, pass into the machine where they drop to a conveyor and are carried by this means to the rear of the machine and on up over the mine car and deposited into this car. However, the conveyor can be swung to one side and the cuttings deposited as refuse in the working place. In other words, this machine cuts out a slate parting and loads it mechanically in one complete operation.

3. A machine which will cut in the coal both above and below a slate parting with two parallel cutter bars of the thin kerf type, this cutting element "straddling" the slate parting. This machine can raise and lower and tilt the cutting element made up of the two cars sufficiently to follow the variations of the slate parting from the mine bottom. The cuttings of coal from this type of machine drop to the mine bottom. The upper bench of coal is then shot breaking the slate parting in the shooting. The upper bench of coal and cuttings are then loaded out. The slate parting which is broken down in shooting makes a good bottom from which to shovel while loading out the upper bench of coal. The slate parting is then loaded back into the mine place, the top of bottom bench of coal being a good bottom from which to shovel. The bottom bench of coal is then shot and loaded out. This method disposes of slate partings too hard to cut.

4. Shearing the coal may also be a part interwoven into the problem of cutting out slate partings, or of making a cut above or below a slate parting. This type of machine to cut and shear is known as the roll-over type and is built to raise and lower and tilt the cutting element a sufficient range for the variation of the slate binder from the mine bottom. The cuttings from this type of machine fall to the mine bottom and are either loaded back or loaded out as the case may be.

It will be observed from the above that the cutting out of slate partings from seams of coal and the method involved is special in each case and depends on the following characteristics of the seam of coal involved:

1. Thickness of the seam of coal.
2. Characteristics of the bottom: Flat, pitching, rolly.
3. Thickness of the slate parting.
4. Cutting qualities of the slate parting.
5. Distance of the slate parting from the bottom.
6. Undulations of the slate parting with relation to the bottom.

The system of mining with relation to width of working place and the room and pillar system of mining is also involved.

The following also are points for consideration:

1. Blasting characteristics of the coal and the blasting medium involved.
2. Thickness and depth of the kerf to be cut with the type and quality of cutter bar involved.
3. The type of the cutter chain with the number of block positions involved, also the type and quality of steel of the cutter bit.

Space does not permit here to take any one case and make an analysis describing in detail the machine which will best function for its work but it is sufficient to say that real progress has been made in many cases of efficiently cutting out slate partings, thus either wholly or partially eliminating cleaning expense of the coal outside the mine.

The retirement of **John G. Barry**, senior vice president of the General Electric Company, after more than 45 years of service, and his election to an honorary vice presidency, was announced by President Gerard Swope following the meeting of the board of directors held in New York on June 28. Mr. Barry, as active head of the apparatus sales organization, has for many years formulated and executed the company's policy and sales program in the apparatus field. He will maintain an office in Schenectady and will be available for consultation. The retirement is effective as of July 1.

* Mining Engineer, Goodman Mfg. Co.

Efficient and Effective MINE TIMBERING

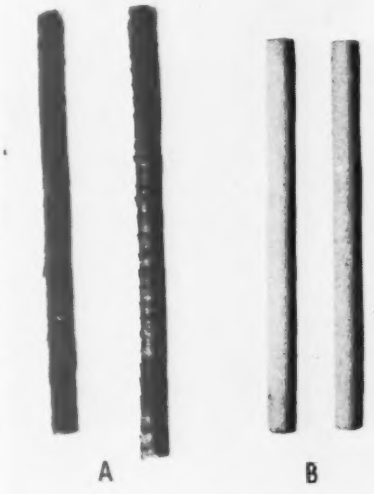
By E. H. RIEMAN*

WOOD is admittedly indispensable to mining operations. Despite the moderate use of steel and concrete in permanent underground construction wood continues to hold preference in that its inherent characteristics lend themselves to this type of service. Wood is a low cost commodity, generally readily available, easily fabricated and convenient to handle. It is highly resistant to corrosive acid waters which limit the utility of steel or concrete but obviously also has its specific shortcoming because of its tendency to rot.

The wood preserving industry has made remarkable progress aimed to retard premature decay and practice of the high standards developed by them may be reasonably expected to extend the life of ties and timber from three to ten times. This is amply confirmed in tie service records recently submitted by one of the principal railroads reporting the life of untreated ties upward from 2.9 years and an overall average of but 5.6 years for all species investigated. In contrast, treated ties with service already in excess of 20 years have not outlived their usefulness. It is predicted that mechanical wear will contribute more to their ultimate destruction than decay.

Considerable data has been published by the U. S. Bureau of Mines, The Forest Products Laboratory and many other authorities advocating wood preservation in the mining industry. Chemical wood preservation offers so many useful attributes beneficial to mining operators that it is difficult to reconcile their antipathy or the reluctance of the industry in general to recognize its utility. No commercial user of ties or timber can profit more quickly from preservation. Coal and metal mines alike are especially vulnerable to rapid timber decay and only suitable preservation can prevent premature replacements. The four essential requisites for rapid propogation of rot producing fungi, viz. air, moisture, warmth and food are normally present in every mine. Modern ventilation systems carrying the spores from existing fruiting bodies throughout the adjacent workings, accelerate the severity of the exposure and rapidly reach new replacements. Obviously, it is impossible to alter conditions involving air, moisture or warmth to control fungi growth but it is practical to poison the existing food supply by rendering the wood toxic, the basic theory of modern timber preservation.

The railroads have demonstrated the economy of preservation notwithstanding that their exposures are far less severe than those present in the mining industry. The economic aspect of preservation for all permanent construction is readily apparent when the fact



A—Borings From Zinc Chloride Treated Timbers in Mine After 24 Years' Service When Sprayed to Determine Presence of Toxic Zinc Chloride.

B—Untreated Borings Showing no Reaction.

is considered that but one replacement far more than compensates the added initial cost preservation imposes. As a matter of fact, on the basis of a normal life of three years for untreated ties and timbers only one additional year of service will reimburse the treating cost, yet such treated ties and timbers will definitely outlive three or more untreated replacements.

The present abnormally low unit cost of ties and timber in face of diminishing supplies should furnish an incentive to modernize and perpetuate all main haulageways and other permanent timbering operations expected to render many additional years of service. Some operators have declared their ability to purchase untreated ties from local sources for as little as 10 cents each and in consequence consider them of too little value to justify preservation. Contrary to this philosophy, these low costs offer a particularly advantageous opportunity to reap the benefit of preservation at an absolute minimum outlay and a guard against vastly increased expenditures in later years. A tie with an intrinsic value of but 10 cents will still cost several times this sum to set in place thus, while highly improbable, if the initial cost should remain relatively the same for many years, labor charges alone during the potential life of a treated tie will total many times the first cost of a treated installation. The normal labor replacement cost of a mine tie is appreciably higher than on a railroad due to the inconvenience of working in confined areas, interruption by frequent train passings and indirectly, by delay or interference with main haulageway movements. Since this article will deal only with generalities, no specific illustration will be cited, however, any mining engineer can quickly determine the vast saving in annual annuity charges by standard tables governing such calculations.

The use of treated ties and timbers also involves many indirect savings difficult to measure in terms of dollars and cents. Often they more than compensate the treating cost. The firm rail bearing surface provided by a well ballasted treated tie results in less weaving and bending with its subsequent damage to the rail and frequently permits using either lighter rail or wider spacing of ties. Ballast will remain compact, spikes will grip more securely and the hazard of derailments materially reduced. In present practice it is also customary to use oversize ties and timbers to allow for anticipated weakening from decay. Preservation eliminates such tolerance needs and will permit the use of dimensions designed to meet the actual load conditions involved. Preservation will also make a more diversified timber supply available. Sap and heartwood of the same species have relatively the same mechanical strength yet the former is classed as "non-durable" because of its greater susceptibility to decay. Sap wood and many of the so-called "non-durable" species respond readily to treatment. In a treated condition they will definitely outlive more expensive untreated heartwood of the better grades

* The Grasselli Chemical Company, Inc., Cleveland, Ohio.

DRILL PRACTICE in Strip Pit Mines

By J. W. SANFORD*

TO HAVE told a strip pit operator, three years ago, that his drilling costs could be cut by two-thirds, that two men on one drill rig in the pit could replace from four to six well drill rigs and their crews at work on the top of the bank, would have seemed like the recital of an enthusiastic salesman's hopes. And that is just about what they were, that summer when equipment builders and pit operators began to seriously get together to do something about the cost of drilling and shooting heavy overburden in the strip pits.

These results, and better, have been secured since then. They have been reported from time to time in papers and articles, so are familiar to the mining profession.

It is now of interest to follow through some of the more important steps of this development as an indication of what startling results can be secured when mine operators and machinery builders throw their abilities together to tackle a tough problem.

The rapid development of steam and electric shovels and drag lines had placed in the pit operator's hands a tool capable of economically moving large yardages if a correctly shot, easily loaded bank, could be kept ahead of the shovel at all times. Delays from digging solid bank, block holding big slabs, and cleaning up fly rock from all over the pit had to be avoided.

It was desirable in shooting overburden ahead of these large shovels to have the explosive charge lift and drop the bank hard enough to shatter it completely, while leaving it standing and without producing any great amount of fly rock. The shattered bank, left standing, was considerably easier to load and the prevention of excessive fly rock minimized the moving back of heavy equipment before the blast.

While all rock layers in the bank had to be thoroughly broken up, shattering of the coal bed directly under the overburden must be avoided if the maximum of profitable lump coal was to be mined.

Securing these very desirable results depended to a marked degree upon the proper distribution of the explosive under the bank to be blasted.

Explosive could be placed at or near the bottom of the bank through vertical holes drilled from the surface or through horizontal holes drilled into the side walls of the bank at its base.

* Sullivan Machinery Company.

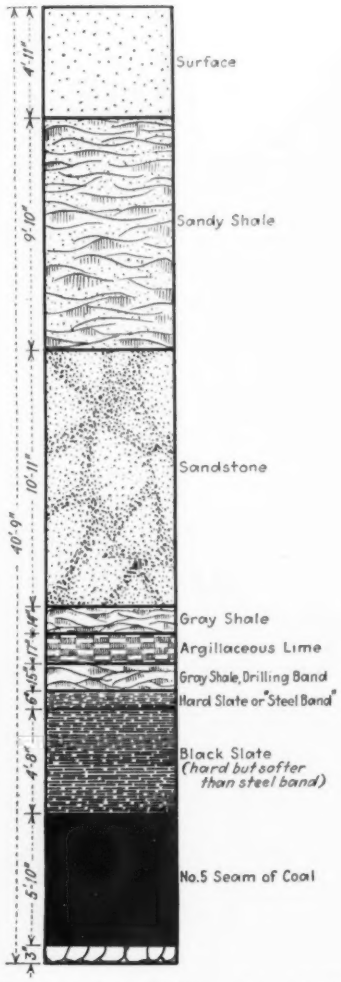


FIG. 1.—*Cross-section of a typical strip pit bank. Horizontal drilling was done in* 15*-inch gray shale band between the hard slate and the lime.*

Explosive engineers and pit operators had studied this problem for many years and had long known that the nearest practical approach to ideal powder distribution on such bank shooting was to be secured by the use of horizontal "lift" holes at the bottom of the bank. These "lift" holes, also known as "snake" or "toe" holes, properly spaced and usually column loaded, showed results surprisingly close to the best results that could be theoretically expected.

Estimates on these two methods are quickly made by laying out the drilling and loading for both methods for typical bank conditions, using conservatively the usual technical data available for explosive engineers and assuming the same diameter drill holes in both kinds of drilling.

It becomes evident at once that the use of horizontal holes, column loaded, will require only one-third to one-half the footage of drill hole that will be needed if vertical drilling is used. This saving increases with higher banks and is slightly less with lower ones.

Explosive engineers are somewhat reluctant to prophesy too closely the comparative efficiency of an explosive when loaded at the bottom of vertical holes and when column loaded in horizontal lifters. Under usual strip pit conditions, however, it can be safely estimated that satisfactory shooting will be secured by loading horizontal holes with not more than one-half the usual charge used in the vertical holes.

With this general acceptance of the advantages of shooting from horizontal or lifter holes, the question arose as to why it had not been more extensively employed in strip pit operations.

The answer seemed to be that there was no drill rig available that could economically drive a 6-inch diameter horizontal hole for 40 to 70 feet under the heavy banks encountered.

Conventional type rock drills could put in lifter holes, but due to the limited size of the drills and to the continuous reduction in gage of the bit, the finished hole was too small in diameter to carry a sufficient charge of explosive to lift the heavy overburden. Enlarging this hole by springing it for almost its entire length was found to be next to impossible.

Some way, therefore, had to be found to put 6-inch horizontal holes under the high banks.

An intensive study was made of the structure of the overburden in the average strip pit and various means were considered for drilling the required lifter holes.

In every one of the many pits examined it was possible to locate a thin band of relatively soft shale a few feet above the top of the coal seam and separated from the coal by harder shale, slate, occasional limestone bands and frequently fire-clay just over the coal. These thin, relatively soft bands could be readily drilled with a small auger drill and it

was felt that if long horizontal holes, 6 inches in diameter, could be economically drilled in these shales that the powder distribution would be almost ideal. Hard shale or rock was immediately above and below the hole to confine the shot. A sufficient buffer of rock and fire-clay below the charge assured a minimum of shattered coal. Holes could be column loaded with explosive uniformly distributed back under the cut and the charge was near enough to the bottom of the hole to enable the blast to lift the entire bank. Moreover, the pit foreman could always be sure the explosive charge was exactly at the right position in the formation above the coal.

As an additional advantage, all drilling could be done from the clean flat top of the coal seam, in the pit with the other equipment and under the watchful eye of the strip foreman.

There remained only the task of providing a suitable drilling rig to put in the horizontal holes.

By this time, machinery manufacturers were busy with the development of drilling rigs and several simpler forms and some experimental units were tried out.

All of the rigs were able to put in the required size and depth holes and the method of shooting from these lifter holes was quickly found to be a marked improvement over shooting from vertical holes.

Continued development of the drill rigs to meet all operating requirements shortly evolved an outfit called the "Stripborer." This rig seemed to fill all specifications for footage per day, ease of handling, mobility, drilling range, and low cost of maintenance, so that marked savings in drilling and shooting costs could be made.

The Stripborer travels forward and reverse under its own power on crawler treads, gasoline engine or electric motor drive, drills, in soft to medium shale, a 6-inch diameter horizontal hole in any depth up to 200 feet and any place from 2 feet to 6 feet above the crawler treads, and can drill at any angle above or below the horizontal.

By the use of special type toothed auger bits and flight conveyors on the drill rods the hole is completely cleaned of all cuttings without the use of water or sludge.

Additional units were quickly built up and many are now in service throughout the coal fields.

Horizontal drilling is now the accepted practice in many properties and careful planning and supervision of all phases of the drilling and shooting method has resulted in saving considerably in excess of those first estimated.

Every pit is a different problem and the overburden in every pit changes as stripping progresses, but the flexibility of the drilling rig gives the foreman every opportunity to study his banks, determine the best location for his blast holes and then put them there.

Wherever possible the holes are put in a relatively soft band of shale, preferably with harder rock above and below, and not too high above the coal.

Horizontal holes are the usual practice but in case of particularly thick rock above the hole, same may be drilled up at an angle. One pit being successfully worked at the present time has a bank from 65 to 70 feet high which includes 8 feet of shale just over the coal and 30 feet of sand rock just above the shale. Holes are on 12½-foot centers, every other hole flat in the shale and the balance angled up into the sand rock. Drilling costs in that particular pit have been reduced by the use of the Stripborer to about one-third of the cost when vertical drilling was done on contract.

In another instance, where the rock and clay formations of a bank require a particularly exact location of the explosive charge, careful planning and supervision of the blasting resulted in the use of only one-fourth the explosive previously loaded in the vertical hole. At the same time, a considerable reduction has been made in the total footage of hole drilled by the horizontal method as compared to the previous vertical hole drilling.

Efficient and Effective Mine Timbering

(*Continued from page* 53)

without sacrificing any mechanical requirements. It is also an accepted fact that partially decayed timber ignites readily. Preservation reduces this hazard.

The wood treating industry recognize two standard preservatives of proven utility. They are the Zinc Chloride salt formulations and Creosote Oil. Chromated Zinc Chloride augmenting unaltered Zinc Chloride is the better of the salt reagents. Other reagents principally of a proprietary character have enjoyed limited use but it is estimated that more than 99 percent of all ties and timber treated employed one or the other of the two accepted standards. The American Wood Preservers' Association standard methods of recommended practice govern the use of Zinc Chloride salts and Creosote Oil.

In the selection of treating reagents for underground use, the absence of odor, harmful constituents, and lack of additional smoke or fire hazards should be considered. Zinc Chloride or Chromated Zinc Chloride meet these requirements and are the preferred reagents for this purpose. Aside from furnishing adequate protection against decay, they possess desirable attributes in that being odorless they are not offensive to the men nor will they destroy warning odors of accumulating gases. They are colorless and will not appreciably alter the appearance of the treated wood, in fact, it may be readily painted where desirable. Zinc Chloride is fire repellent and will measurably reduce the inflammability of the treated wood. In contrast, Creosote when ignited yields dense volumes of obnoxious smoke. Zinc Chloride and Chromated Zinc Chloride are also free from arsenicals and toxic volatile organic chemicals harmful to the human system. It is considered the safest reagent for underground use. It has been contended by some that Zinc Chloride salts leach and become ineffective. This has not proven true in practice as evidenced by the splendid service this reagent is rendering in millions of cubic feet of mine ties and timbers over a period of many years.

The wood preserving industry has progressed beyond experiment and mine operators can benefit themselves materially by fuller recognition of preservation in its present high state of development.

Fan Specification Suggestions

(*Continued from page* 27)

to the babbitted bearing for heavy installations.

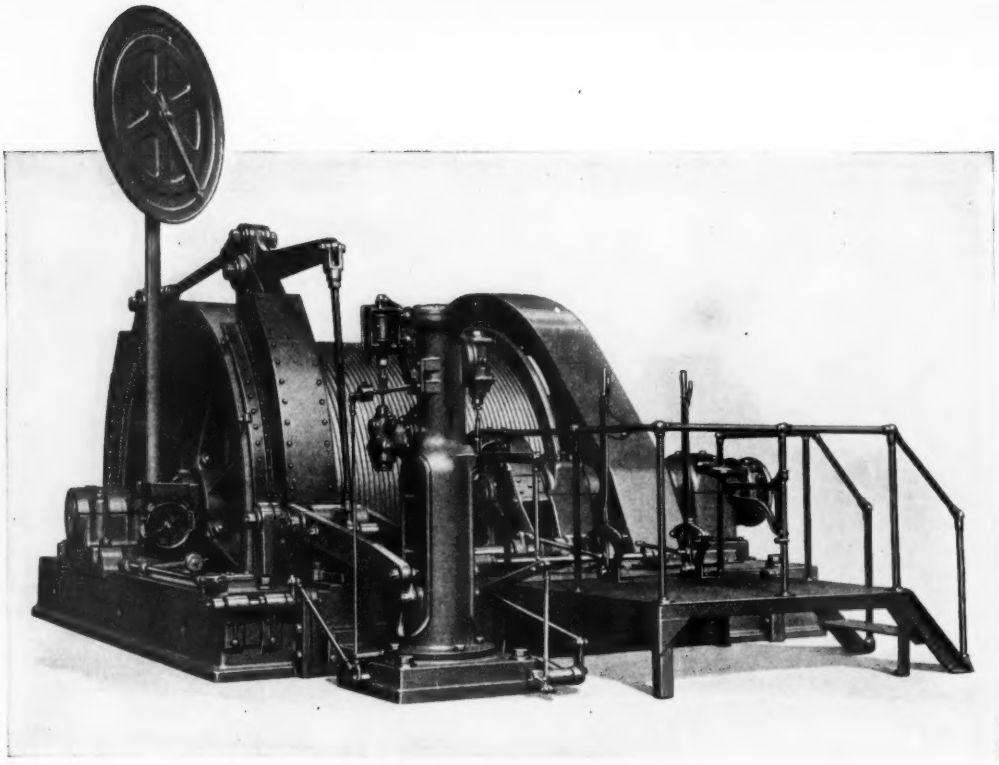
15. Specify that the fan bearings on a heavy installation, that is, on fans 6 ft. in diameter and larger, shall be supported on each side of the casing by cast iron pedestals independent of the casing, and that the pedestals extend down to the floor line of the fan drifts.

16. On fans of 6-ft. diameter and larger, a three-quarter casing is recommended. It should be constructed of not less than 3/16-in. steel plate reinforced with necessary stiffening members in order that it will perform its maximum duty without undue vibration. It should be specified that the pressure due to the velocity in the side drifts and at the top of the chimney shall not exceed 6 percent of the rated pressure. The chimney expansion should be approximately 7 degrees.

17. If the fan is of the reversible type, specify that it shall be furnished with the necessary steel doors for reversing the air in the drifts, and that they shall be provided with the necessary hinges for attachment to the casing. Specify that the chimney be fitted with a damper, together with the necessary operating mechanism.

18. In case steel side drifts are specified (see Item 7), then designate that a steel air lock be furnished, together with two steel doors fitted complete with necessary latches and hinges. If masonry drifts are used, then two air lock doors set in channel iron frames should be furnished for building into the air lock walls.

19. The purchaser should request the diameter and width of the fan in feet or inches. He also should require that the revolutions and brake horsepower be given for the specified duty. The fan manufacturer should furnish a characteristic curve of the proposed fan and a general layout drawing showing the proposed installation.



Single Drum Slope Hoist

Modern Slope HOISTING Practice

By A. J. NICHT*

SLOPE hoists are employed perhaps more at coal mines than at metal mines. They are sometimes of the single drum type, hoisting or lowering on a single track, while in other cases they are of the double drum type, hoisting in balance on a double track or the equivalent thereof.

The design of the slope hoist is essentially the same as that of a vertical shaft hoist, except that the rope pulls are less for the gross load handled, depending upon the angle of inclination of the slope.

Permissible safe rope speeds on slopes are considerably less than allowed in shaft hoists, being affected by the condition of the track, the weight of the rails, variation in the slope, curves in the slopes, etc.

The hoisting ropes used on a slope hoist must be oversize from that actually required for the rope pull with the proper factor of safety on account of the extra wear and tear encountered due to dragging on the ground and running over the rollers.

For fairly high-speed operation on inclines a good well-maintained road bed equipped with around 100-lb. rail and uniform slope is essential.

An example of a recent modern single drum high speed slope hoist is shown by cut No. 27425. This hoist is designed for a maximum rope pull at the drum of 20,000 lbs. and operates at a speed of 1,800 ft. per minute. The drum is welded steel plate construction, 90-in. diameter by 72-in. face, is keyed to the drum shaft, and winds 2,300 ft. of 1⅜-in. rope in two wraps.

The hoist is equipped with an oil-operated parallel motion 9 ft. 0 in. diameter structural steel post brake lined with asbestos brake blocks. It is possible to secure very delicate control of the hoist speed with the particular braking system employed.

The hoist is also equipped with complete modern safety features to prevent overwinding, overspeed, etc.

The gears are single reduction Falk herringbone type and the pinion shaft is connected through a flexible coupling to a .700 hp., 2,200-volt, 60 cy., 3 ph., 589 rpm. wound rotor induction motor, supplied with full reverse magnetic control.

THE Pond Creek Pocahontas Company, coal operator at Bartley, West Virginia, required additional air for its ventilating system and a means of improving its load power-factor. Selected to replace the old drive, a 600-hp. General Electric synchronous motor with related control now supplies ample ventilation at all levels of the 650-ft. shaft, and the needed corrective kv-a. to the power system. This change, resulting in a saving of $1,000 a month, paid for the new equipment in the first year of operation, according to the coal company, and from now on will yield, under existing conditions, a 100-percent annual return on the investment.

* Engineer, Allis Chalmers Manufacturing Co.

New SAFETY Equipment Ideas

By J. T. RYAN*

MINING in the past has been one of the most hazardous of our major industries. Accidents, fatal and non-fatal, have exacted a very heavy toll from both the humanitarian and financial standpoints. However, research engineers and manufacturers, working hand in hand, have invented and developed appliances which have minimized the hazards which miners must face and have also made possible a considerable saving in cost of operation. Although some of these appliances have been in use for several years, recent improvements upon them have widened the scope of their service to the mining industry.

Writers on the subject of safety in mining have truthfully stated that the introduction of the permissible electric cap lamp has done more to increase safety in underground operations than any other single piece of equipment. The early models of permissible electric cap lamps were developed to supply a more efficient source of illumination and to remove the danger of gas ignition. Permissible electric cap lamps have been developed to such a high state of efficiency that, aside from the protection afforded against explosive gas, the quantity of illumination provided by this lamp warrants its general use in all mines, regardless of character.

The miner, in either coal or metal mines, supplied with this model lamp, is assured dependable, carefree illumination throughout the working shift and because of the abundance of light provided becomes a more efficient workman. Mine managers at properties where the electric cap lamp has been installed have reported fewer accidents and increased production with resultant lower costs, due to the greater and more uniform illumination and the saving in time which formerly was consumed in servicing the open type of lamp.

The mining industry, probably more than any other, has to give attention to head protection among its workers.

Protective hats and caps, known as skullgards, have been perfected to such a degree that they are comfortable to wear and provide protection against falling objects.

To illustrate the value of head protection, one large mining company in the period of 1929 to 1932 reduced its compensation and medical costs, due to head injuries, by approximately $7,500; another company produced more than three times as much tonnage per head injury as they did before the adoption of skullgards. There are so many instances of skullgards having saved lives or prevented serious injuries that space will not permit enumerating them. However, managements and mine workers are realizing to such an extent the necessity of reliable head protection that the use of this type of protection is increasing daily and at many mining properties no one is permitted underground without it.

Eye injuries are one of the most expensive of all mine accidents. In one large mining state, during a 10-year period, more than 10,000 miners received eye injuries, which resulted in total or partial blindness, and in the same state, over a four-year period, 25 percent of the total compensation cost paid to mine workers was expended for eye injuries. However, eye injuries are among the easiest and least expensive to prevent, because of the fact that goggles suitable for every purpose are available for the protection of the workman.

A prominent safety engineer has stated that in approximately one and one-half years after the use of goggles had been made compulsory at his properties, eye injuries had been completely eliminated, and that prior to that time eye injuries had been costing his company from several hundred to several thousand dollars per year.

At another mining operation, after underground workers had worn goggles continuously for two years, eye injuries had dropped 95 percent.

Dust is one of our more prevalent industrial hazards, existing in greater or lesser degree in most industries. Its harmful effects on workmen as a contributory source of pulmonary ills is a matter of common knowledge. Even when there are no visible clouds of dust, scientific tests prove that the atmosphere in many working places may contain dust in sufficient quantities and of such character as to cause a serious health

(*Concluded on page* 61)

* Vice President and General Sales Manager, Mine Safety Appliances Company.

MECHANICAL LOADING in Thin Seams

By J. S. HOUSMAN*

THERE are two distinct divisions in mechanical loading—first, that in which the material is loaded direct from the face into the mine car; second, where the material is transported from the face to the entry by a scraper, shaker conveyor with duckbill, or some other means. The second division, in the past, has been limited to various types of scrapers and shaker conveyors.

Belt, chain or shaker conveyors which do not have a mechanical self-loading device cannot be classed as mechanical loaders, since they merely function as transportation systems.

Mechanical loading in thin coal presents problems, many of which are similiar to those in thick seams but on the whole a great deal more difficult to solve. This is true not only from the coal operator's standpoint but from the manufacturer's as well.

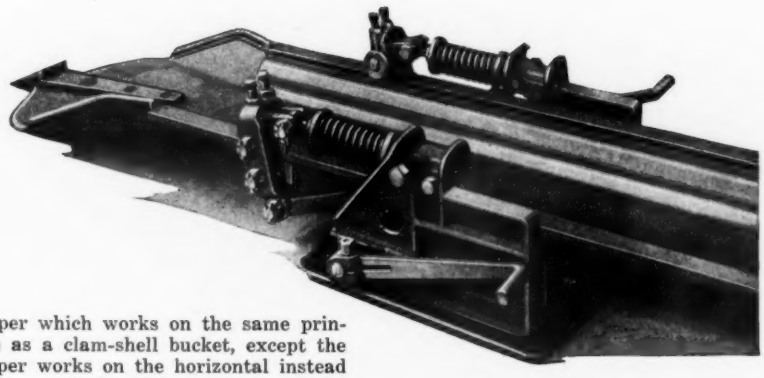
Scraper loaders have demonstrated their ability to work either on long faces, room and pillar, or entry driving.

A typical installation on long face work was one in which the coal seam was about 40 in. thick and overlain by 12 in. of draw slate. The draw slate came down when coal was shot and was handled by the loader crew. Under these adverse conditions the mine was able to average about 200 tons per shift with a 12-man crew divided up as follows: foreman, hoist operator, shot firer, three face men, cutting machine operator and helper, two timbermen, car hoist man and coupler. The face was 250 ft. in length.

A mobile type of scraper loader hoist is used for room and pillar work. This loader can be moved from room to room, set up, and operating in about 30 minutes. Scrapers of this type have been used in coal as thin as 20 in. The crew normally consists of five men and under good conditions average anywhere from 20 to 40 tons per man.

Scrapers have been used extensively in narrow work where shooting can be done at any time during the day. The general average for work of this kind with a three or four-man crew in a 12-ft. entry is from three to four cuts per shift with the crew doing the cutting, shooting and loading. The coal is hand shoveled into the scoop, consequently in this type of work the apparatus becomes more or less a transportation unit.

Some installations use an open end scraper which works on the same principle as a clam-shell bucket, except the scraper works on the horizontal instead of the vertical. This type of scraper permits the crew to keep shoveling into a pile while the scraper is pulled out to dump the load and on its return the back of the scraper is open and pulls through the pile, the doors closing when the pull comes on the head rope. The record for this kind of work, we believe, is eight cuts in an eight-hour shift. This record, of course, has no practical value as it would be impossible to maintain under actual working conditions.



The anthracite field where scraper loaders were first used on a large scale have been using this method of mechanical loading to produce a considerable tonnage over a period of years. The scraper loader is used on modified long face work and in chambers or breasts.

In both anthracite and bituminous mines the scraper loader has proven its adaptibility for practically any mining system in thin coal. It has been used with success on pitching seams for moving coal up and down the pitch.

A recent installation of a mobile scraper loader in rock work at a mine in West Virginia has proven very successful. The loader is used on week ends to load out rock in entries. The coal company now plans to use it on the other days of the week for development work.

Scraper loader hoists are built in various sizes from about 7½ to as high as 125 horsepower. The scraper holds anything from approximately 500 to 10,000 pounds.

The shaker conveyor, until a few years ago, was merely a transportation unit but later was transformed into a mechanical loader by the addition of the duckbill. This device has proven very satisfactory, both in loading coal and rock, and is not confined to development but can be used satisfactorily in room and pillar work. It has also been used in underground work on long faces.

In a certain mine heading work is advanced about 300 ft. per month on a single shift. The heading is about 6½ ft. in height. The coal seam is about 3½ ft. in thickness and about 3 ft. of rock is brushed. A three-man crew averages about three cuts per shift loading both coal and rock.

No doubt in the near future there will be many designs of mobile or semi-mobile loaders brought out for use in low coal either loading on conveyors or in low mine cars.

The choice of equipment whether mobile or immobile should take into consideration all phases or factors involved.

A careful analysis of the mechanical and mining problems should be made so that the most suitable type of loader can be selected.

The selection of the mining system for the piece of loading apparatus chosen is vitally important. A good loading machine may become a failure due to improper application, also a good mining plan may be unsuccessful due to poor selection of the loading equipment.

Many mechanical loading devices are operating successfully in mines originally developed for hand loading. It is highly improbable that a mining plan which has proven to be suitable for hand loading will prove adaptable for mechanical loading without any changes. Numerous operations are now carrying on profitably due to the concentrated method inherent in a well laid out mechanical loading scheme, the profits due

(*Concluded on page* 60)

* Loading Engineer, Goodman Mfg. Co.

The Use of POWER SHOVELS in Driving Tunnels

By DOUGLAS C. CORNER*

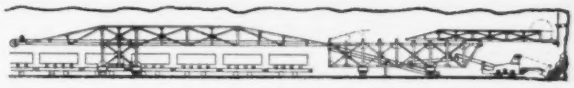
THE EFFECTIVENESS of power shovels in tunnel driving is so dependent upon auxiliary equipment that we find great development in these items during the last few years. In other words, the changes in the shovels themselves have been comparatively few; for instance, the Conway Mucker, manufactured by the St. Louis Power Shovel Company and built in the Goodman Manufacturing Company's plant in Chicago, has important improvements which have helped the tunnel builders in attaining high speed records, but the use of other items of auxiliary equipment in conjunction with the Conway is what has played the most important part.

Progress records of such importance are being made almost every month on western rock tunnels that it is of interest to study the causes. There has been so much recent improvement that surely a good and sufficient reason for it must exist. It used to be said that "rock makes the records" and it is true that the formation still plays an important part, but there are other factors which are contributing to increased progress.

In the MINING CONGRESS JOURNAL of January 1930, the writer presented an article entitled "Integrating System of Car Loading." At that time the system was more or less a hope and a prophecy; it is a source of great satisfaction that at least a modification of the system has been used with most gratifying results on the center headings of the Fort Peck Tunnels, for which Mason-Walsh is the contractor, and also on the West Eagle Mt. Tunnel of the Colorado River Aqueduct, Dixon and Bent, contractors.

* Mining Engineer, Los Angeles, Calif.

King Grasshopper—Combination Car Switcher and Drill Carriage



Multiple Car Loading Conveyor and Drill Carriage—Simultaneous Mucking and Drilling in 19x19-Foot Tunnel

Multiple Car Loading as Used on Fort Peck Diversion Tunnel Headings

But certainly the use of this car loading plan does not account for all of the improvement, as other record-breaking tunnels are using radically different systems of car switching. A variety of these systems are being used on the Aqueduct Tunnels being driven by contractors, the most original of which is the King Grasshopper, which permits passing of empty cars over the loads. This machine, which was devised by Mr. Herbert King, also serves as a drill carriage; it may be seen on the Hamilton-Gleason, Walsh, Morrison-Knudsen, and Shea contracts.

The Dixon Multiple Car Loading Conveyor which permits the loading of a trip at a time, combines multiple car loading with a drill carriage, and will ultimately serve as a carrier for the concrete lining forms. This device may be seen on the Dixon-Bent job.

The Wallace Young Cherry Picker which lifts the empty car high enough vertically to clear the loaded cars is an enlargement on the Dan O'Rourke Cherry Picker that was first used by Hitchcock and Tinkler on the Moffat Tunnel.

The idea behind these various car switching devices is a consideration of the fact that all loading activity must wait until there is an empty under the conveyor. This makes it evident that the speed with which empties are brought into loading position is the key

TUNNEL DRIVING RECORDS

Contractor	Tunnel	Size	Material	Best Month	Best Day
A. Guthrie & Co.	St. Paul, Minn. Sewer	14′ x 14′	Sandstone	July '29, 1,466′	63.7′
Mason-Walsh Co.	Fort Peck, No. 3 Diversion Heading	14′ x 16′	Shale, timbered	Jan. '35, 1,508′	48.6′ avg.
Utah Constr. Co.	West Iron Mountain, Columbia River Aqueduct	20′ x 20′	Gravel and rock, timbered	Nov. '33, 1,027′	46.5′
L. A. Dept. Water & Power	Mono Basin, L. A. Aqueduct Extension	12′ x 12′	Rock	Apr. '35, 1,219′	72′
Walsh Constr. Co.	Whipple Mountain, Colorado River Aqueduct	19′ x 19′	Rock	Mar. '35, 1,084′	55′
Dixon-Bent & Johnson	Pasadena, Colorado River Aqueduct Distribution	12′ circ.	Gravel, timbered	Apr. '35, 1,504′	17.7′ avg.
Metropolitan Water District	Coachella, Colorado River Aqueduct	19′ x 19′	Rock, timbered	Feb. '35, 942′	54′

to the problem of accelerated muck-moving. To be sure, special explosives for various rock conditions together with electric delayed detonators provide better preparation for fast mucking. A careful choice of the appropriate mucking machine to fit the underground conditions is imperative if the tunnel is to be mucked in record time. Fortunately for the Conway, it has seemed to fit most conditions and to work readily with a variety of car switching systems and drill carriages.

Rather than give only individual honors to each phase of the improved loading systems, I feel that much credit should go to the men who conceived the cooperative working of these different units and provided for such cooperation by careful planning, and to the men who carry these plans into actualities. I believe that a large part of the improvement is to be found in better planning and more careful correlation of equipment before any purchases are made, together with the fact that the personnel is of a very high order. For example, Mr. Rush Sill, consulting engineer of Los Angeles, spent many months studying conditions and preparing a report and a set of complete specifications for driving the 13-mile Mono Basin Tunnel, which, largely as a result of this planning, is going forward at a maximum speed and at minimum cost under the able direction of Mr. H. A. Van Norman, of the Los Angeles Board of Water and Power. In this case, particular attention was given to the width of every piece of equipment, so as to facilitate its passing in the tunnel; a special narrow-width Conway had to be designed to meet their condition of 45-in. maximum width, which was the limitation for all equipment in this 10-ft. finished horseshoe shaped tunnel. On this work, car switching is accomplished by the use of a portable four-rail passing track which is superimposed on the 24-in. gage single track, centrally located main line.

At the start of the work for the Colorado River Aqueduct, the Metropolitan Water District employed Mr. A. C. Dennis as consulting engineer, and he directed the preparation of equipment specifications, recommending the largest possible units that could pass at high speed in this 20-ft. excavated horseshoe shaped tunnel. Mr. Dennis' recommendations for correlating equipment were followed with the result that the progress has been little short of phenomenal. He urged large 60 h-p. electric mucking machines, 5-cu. yd. steel side-dump cars, and 8-ton locomotives. On the Coachella Tunnels of the Colorado River Aqueduct which the Metropolitan Water District is driving with its own forces, the California Switch has its greatest use. The loads are taken from the mucking machine by the locomotives, and the empties are pulled in off the switch by a hoist mounted on the mucker.

In the great improvement of tunnel methods I believe that we can see an inspiring example of the cooperation of man and equipment that has marked our determined emergence from the throes of the great economic depression. If tunnel construction can be considered a business barometer, and there is no reason why it should not, then we can feel that our economic weather is and will be fair.

Time Studies

The following is a fairly accurate summary of data pertaining to the east heading of Long Canyon Tunnel and the west heading of Seven Palms Tunnel:

Metropolitan Water District of Southern California
Colorado River Aqueduct
Mr. R. M. Merriman, Division Superintendent

Length both tunnels, approximately	30,000 ft. 16′ x 16′ finished size, concrete line
Rock	Various, mostly hard, blocky granite gneiss
Object	Water supply
Crew	Three shifts per day of 15 men each; consisting of shift boss, mucking machine operator, 5 miners, 5 chuck tenders, 2 motormen, 1 brakeman
Drill carriage	5 drills (Worthington H-80)
Mucking machines	3 Conways, 60 hp., all electric
Trackage	36-in. gage, 40-lb. steel rails, California switch
Cars	Western 5-yd. all-steel, roller bearing, side dump

Average Cycles

Average drill round	38 holes of 9 ft.
Average round mucked	24 cars
Average time mucking	2 hours
Average time of cycle	5 hours
Maximum daily footage	54 ft. (one heading)
Maximum monthly footage	945 ft. (one heading)

Average Shoveling Time

Ventilation	25 minutes
Loading completed	2 hours
Total	2 hours, 25 minutes
Yardage	7½ ft. of 19′ x 19′ excavated tunnel, 24 cars (144 cu. yds.)

Average Drilling Time

Taking in drill carriage and setting up	10 minutes
Drilling	2 hours
Tearing down, blowing holes, loading, blasting	25 minutes
Total	2 hours, 35 minutes
Footage drilled	342 ft., using 1¼-in. hollow drill steel
Explosives	200 lbs., 40% gelatine
All force account	

Data Furnished by Mr. C. E. Sides, Superintendent of Long Canyon Camp, Colorado River Aqueduct.

In the mine every effort must be made to keep the apparatus working. Tonnage lost by any delay is forever lost because a loader loads at its maximum efficiency at all times. In other words, there is no possibility of speeding it up and regaining lost time.

With proper cooperation there is no doubt of the success of mechanical loading. A large return has generally been shown on the original investment, which is the final judgment.

Mechanical Loading In Thin Seams

(*Continued from page* 58)

to the intangible savings in mechanical loading being a very considerable amount. Mechanical mining in the United States has passed the experimental stage and has a very firm footing in the industry.

In conclusion, it may be stated that the history of mechanical loading is a repetition of the history of other mining machinery. The cutting machines passed through the same process of evolution and improvement. Mechanical loaders have successfully passed through various stages and one point has been clearly demonstrated—to make a success of a loading machine in a

MANY colleges have used a film from General Electric showing the use of electricity in mining and handling of anthracite in mines and breakers. It shows the use of machinery in elevators for men and coal, pumping air and water, electric face cutting, hauling coal from mines to elevators, to breakers, etc. It portrays the different types of mining, such as drift, slope, and shaft, as well as the earlier methods. It is furnished to economic geography and geology classes, and is one of a series of American manufacturers' films on the chief industries in the country.

New Safety Equipment Ideas

(*Continued from page* 57)

hazard if approved respiratory protection is not afforded the worker.

Successful safety methods, therefore, require the adoption of highly efficient respiratory protective equipment that is designed so that workmen can and will wear it without the inconvenience of high breathing resistance and excessive weight. These were the objectives of the M. S. A. research laboratories in developing a respirator, which has recently been approved by the United States Bureau of Mines—the first respirator to be approved by the Bureau under their permissible schedule—and which furnishes protection against fine dust down to a fraction of a micron in size and combines this feature of protection with utmost comfort to the wearer.

Adequate ventilation is essential in all underground operations, in order to supply a satisfactory atmosphere for workmen and to dilute and remove all dangerous gases. The cost of ventilation often reaches a sizable figure and economical mine operating and good safety practices dictate that the ventilating current should be checked at regular intervals. Recently, the Mine Safety Appliances Company has developed methane detectors and methane recorders of such sensitivity and accuracy that ventilation efficiency can be increased with a minimum of delay by properly directing the ventilating current, with the result that greater safety and in many cases lower ventilating costs are obtained.

Although such equipment as oxygen breathing apparatus, gas mask, inhalators, self-rescuers, and rock dust distributors are not of recent development and are familiar to so many people, it is fitting and proper that attention should be called to their value in times of emergency in saving life and in reducing the damage to property.

Research engineers and manufacturers have kept pace with the demands of industry for accident prevention devices and, as new hazards arise, we may be assured that new developments and improvements will be available to combat them.

Co-ordination of Mine And Fan Characteristics

(*Continued from page* 32)

equivalent orifice is section BB, or 16 sq. ft.

Now, when a fan is used to propel the air, the operating characteristics of the fan will determine the amount of air that will flow, while the fan operates at a constant speed, when the equivalent orifice changes. The following tabulation shows the general performance of three distinct types of fans when the orifice changes from 22.4 sq. ft. to 16 sq. ft. and to 8 sq. ft. The fans are designed to operate at E.O. of 16 sq. ft.

TABULATION

Section	Sq. Ft. E.O.	Quantity	Static Pressure	A.H.P.	Es	B.H.P.
Figure 3						
BB	16	100,000	6.25"	98	74%	132.5
CC	8	53,000	7.05	58.7	60	97.8
AA	22.4	128,800	5.25	106	70	151.5
Figure 4						
BB	16	100,000	6.25	98	60	163.5
CC	8	50,000	6.16	48.5	42	115
AA	22.4	127,500	5.18	104	50	208
Figure 5						
BB	16	100,000	6.25	98	48	204
CC	8	58,000	8.4	76.5	36.5	209.5
AA	22.4	123,000	4.85	93.75	42.5	220

If constant volumes must be maintained, the speed of the fan must be changed to deliver the required volume with the existing equivalent orifice, and the efficiency of the fan at the new speed will remain as observed for that orifice.

By use of a chart, on which the characteristics of the fan are plotted, the speed of the fan can be calculated quickly.

It is important that the characteristics of the fan are such that it will show quickly on the water gage the change in equivalent orifice, Figure 3, and that it will operate over a wide range of conditions with high efficiency. But, before the fan can be selected properly, accuracy in determining the mine characteristics must be employed.

Mining engineers should adopt a code of procedure which would prescribe uniform methods of determining as accurately as possible the amount of air flowing in airways and the pressure differential which causes the flow.

Airdox

(*Continued from page* 58)

The combination of a deeper cut and a thinner kerf may seriously affect the efficiency of the operation of breaking down the coal for easy loading. It is much more difficult to remove the bug dust thoroughly from the undercut and also more important that the job be properly done.

Everyone will agree that the use of deeper undercuts tends to increase the difficulty of "balancing the shots" and may result in reduced efficiency in this department of the work. The low holes must be placed so as to carry their snubbing effect all the way to the back of the cut and provide an opening that will give room for the top to break down completely and roll over. With Airdox the best results have been obtained by dipping the low holes toward the back of the cut. The heaving action of low pressure air released in these low holes rolls out the bottom, and a similar charge rolls out the top. This is illustrated by the pictures published herewith which show a face after the snubber has been broken on the right rib and after the top has been broken down on the lower coal. From these illustrations it can be seen that a loading machine will have no difficulty in proceeding to the back of the cut without delays caused by digging in tight coal.

As stated earlier, in high tonnage mechanical loading units, the time required for traveling between working places becomes of great importance as the number of faces to be loaded increases. The constant aim of management is to increase the time efficiency of the controlling unit. Here again Airdox enters the picture through its ability to concentrate the operating area into a smaller number of working places. Thus the distance the various units have to move is reduced, while the number of working faces is reduced as much as one-half, for the same tonnage. Where mining conditions are uniform it becomes possible to work all units in a constant cycle, keeping only enough extra places to prevent minor delays from affecting other units in the territory. The crew produces in one shift the tonnage requirement of two of the high tonnage loaders under discussion.

PORTABLE LAMP AND EQUIPMENT CO. have just released Bulletin No. 102 describing this complete line of coal caps and cool hats which are now equipped with the new flexible ventilated forehead band.

Copies of Bulletin No. 102 will be forwarded to all interested parties.

"METAL—MINING—MONEY" is ARMCO's newest mailing peice to coal mining companies. They will be glad to supply any demand for the pamphlet if request is made to the American Rolling Mills Co., Middletown, Ohio.

COAL SAWS Aid Face Preparation

By DEWEY E. JOY*

THE ultimate objective of the coal operator is to produce a product of such commercial value that it will enable him to meet competition and at the same time conduct a profitable business. This has prompted the management of many mines to direct their thoughts and attention more and more to the preparation of their coals at the working face.

The physical properties of a coal seam together with the potential market for the resulting product should for obvious reasons influence the amount of money a company can afford to spend in an attempt to work out a system of face preparation. In some instances the demand for coarse sizes has justified large capital expenditures for this purpose. In others the separation of impurities from the coal has been of paramount importance. In recent years, however, as the market demands have become more exacting and the cleaner seams of coal are diminishing in number, the difficulties of producing a marketable product have rapidly multiplied.

The problem has been approached from many different angles, most generally by closer supervision at the working face because it was considered the least expensive. A more careful selection of the proper kind of explosive to dislodge the coal has also produced beneficial results. The application of specially built cutting machines to permit cutting the seam at some desirable point, either in coal or in stratified bands of impurities, has perhaps contributed more to the solution of the problem than any other method adopted. In this respect the coal saw, because of its unusual flexibility, lends itself especially well to the average mine as an aid in the solution of face preparation difficulties.

These machines embody several unique features of design which permit the rapid sawing of 2 to 3-in. kerfs in the coal face. These thin kerfs may be made horizontally at any point between the top and bottom of the seam. The saw blade or cutting element can then be quickly rotated to a shearing position and similar kerfs made vertically from the floor to the roof at any point between the sidewalls of the working face.

During the early period of development the coal saw was constructed to perform all of its sawing operations while resting on the mine floor. The sumping and shearing functions were accomplished by a system of hydraulic cylinders and controls. Lateral feeding was obtained by the use of ropes and drums quite like those employed on the modern shortwall mining machine. Self-propelled trucks were used for quick transportation from one face to another.

Figure 1 is a view of such a machine in the actual preparation of a coal face. The coal has been undercut, topcut, centercut, and sheared four times, once at each rib and twice near the center.

An accessory to the coal saw is a device known as the hydraulic breaker pad. This pad is inserted in the top horizontal kerf and inflated to break down the cut. It is capable of exerting an ultimate pressure of 150,000 pounds which is more than sufficient to break down not only the coal but the most stubborn bands of slate or bone coal as well.

In the particular instance shown in Figure 1, the center horizontal kerf was made just above a 3-in. slate parting which adhered to the upper bench of coal but had a free separation from the lower bench. The miner is thus enabled to load out the top bench first by the simple use of a specially made coal bar. The slate band is then removed and gobbed, after which the lower bench of coal is loaded out.

The early experiments taught that the natural structure of most coals are such that once the cut is dislodged at the back it is quite a simple matter to reduce the large blocks to a convenient size for loading. With few exceptions there are either vertical or horizontal cleats in the coal that show a tendency to open up or part when the cut is loosened at the back. These cleats are usually from 3 to 24 in. apart and by inserting the point of a bar or pick into these cracks the miner can roll out the large lumps and load them without unusual exertion on his part.

In most instances where coal saws have been installed the miner shows a preference for loading the coal prepared by these machines. He is not required to drill holes or furnish explosives. Consequently more of his time is devoted to the actual loading of coal enabling him to clean up his cut in less time and in some instances has resulted in increasing his earnings.

Figure 2 is a view of the same working place as shown in Figure 1, with the top bench of coal removed by the use of a bar. Even though a total of 88 lin. ft. of cutting was performed by the saw in this 24-ft. room the percentage of slack was approximately 25 percent less than before and the coarser sizes increased proportionately. The ash content of the slack was lowered more than 2 percent and the lump product reached its mar-

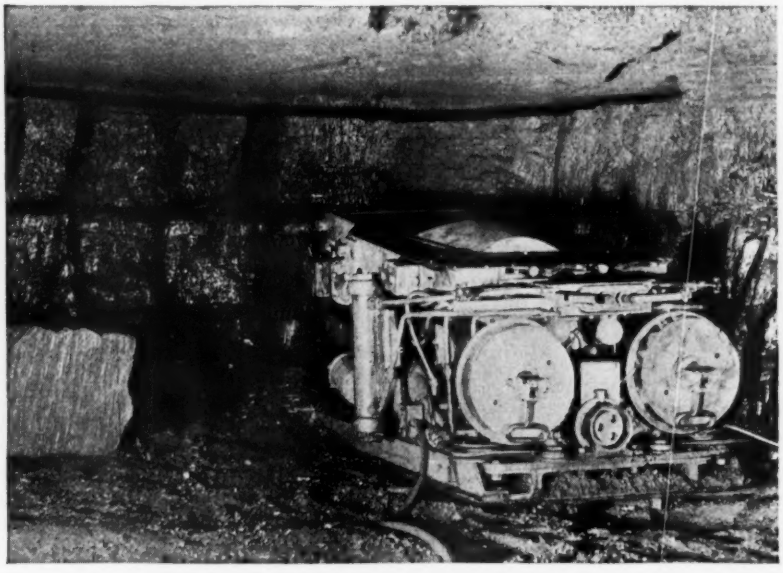


FIG. 1.—*Floor Type Coal Saw Shown During the Actual Preparation of a Coal Face*

* Sullivan Machinery Company, Chicago, Ill.

FIG. 2.—*Coal Face Prepared by the Saw and Dislodged With the Hydraulic Breaker Pad Ready for Loading*

FIG. 3.—*The Trip of Cars in the Foreground are Loaded With Sawed Coal. The Trip in the Background With Shot Coal and From an Adjoining Section of the Same Mine*

ket with less than half as much degradation.

There is, of course, a limit to what a concern can afford to pay to obtain results such as those outlined above. For this reason it may seem that costs of cutting are high, due to the amount of cutting necessary. It is interesting to note, however, that the above description covers a case wherein the amount of cutting was unusually large, yet economically justified by the increased realization secured.

The physical characteristics of a coal seam determines the amount of sawing required. In some instances it is only necessary to make one horizontal cut at the bottom of the seam and three vertical cuts, one at each rib and one in the center. Seldom are more than two horizontal and four shear cuts required and quite often the use of the hydraulic breaker pad to dislodge the coal is not needed. With the coal cut on all sides, its weight suspended for a depth of 5 or 6 ft. is sufficient to break the coal at the back of the cut with the same result as that obtained from the breaker pad.

Again, the combination of sawing and light shooting has produced very beneficial results. In one instance this method was adopted where it was desired to separate a 1½-in. bone parting at the bottom of the seam and another 10-in. bone parting at the top of the seam. Two horizontal cuts were made, one just above the bottom bone and the other just below the top bone. A shear cut was then made in the center of the place and a light Cardox shell placed in each side to dislodge the coal. The sawing is done by contract for the same rate as that previously paid to shortwall machine operators for the reason that it does not require any more time to prepare the coal as described than it did to make one cut across the face with the shortwall machine. This mine is now producing all of its coal with saws in this manner.

In another instance the cost of sawing the coal is 1½ cents per ton more than the shortwall rate but the loading rate is 3 cents per ton less as the miner is not required to furnish any shooting material. There are other instances where the cost of sawing is considerably more than by the previous method but the increase in sales realization obtained for the resulting product has more than offset this additional cost and left a nice margin of profit as well.

Figure 3 affords an opportunity to compare the difference in appearance of sawed coal and shot coal from the same mine. The trip of cars in the foreground are loaded with the sawed coal and the one in the background with shot coal. This was an unintentional contrast at the time the photograph was taken, but after printing was noted as a significant example of what coal saws will contribute toward better preparation of coal at the working face.

In keeping with the trend toward track cutting equipment, a track mounted coal saw was developed and perfected a few years ago. This machine has a sawing capacity about one-third greater than the floor type. The shearing range is 12 ft. on either side of the track center line. It has a vertical adjustment that permits horizontal cutting at any point from 12 in. below the rail to 6 ft. above but can be built to cut as high as 8 ft. above the rail.

Repair costs on the present day coal saws of all types compare favorably with other types of mining machines. This, however, is largely dependent upon the particular application and the amount of sawing necessary to obtain the desired result on a given tonnage.

Weighing as a Factor In Production Cost

(*Continued from page* 34)

accuracy this time can be reduced to one-half, or one-third, or as is actually accomplished by the use of automatic recording weighers, to one-fifth the hand weighing time the number of cars required to move coal out of the mine may be substantially reduced. Further, if the flow of cars is not continuous, employes who otherwise would be engaged in the operation of hand weighing are, through the use of an automatic weight recorder, afforded time which may be used for other purposes. The machine thus saves a waste of capital expense in rolling stock and reduces personnel expense. The reputation the automatic recorder enjoys for producing authentic weights coupled with its economies in personnel expense is reflected in the simple statement of fact that recorder equipped mines do now and have operated for years without either weighman or check weighman.

The economies of fast weighing are especially noteworthy at points where trains of ore are concentrated for weighing where, under average conditions with a volume of 500 cars per day (a lower than average figure), the weighing expense per scale is by the use of an automatic recording weigher reduced over $3,000.00 monthly. This is actual saving in out-of-pocket expense involved in moving cars over the scale and performing the weighing operations. It does not include the interest saving on the capital investment in extra weighing equipment nor the extra personnel and maintenance costs if hand weighing practices were followed.

Automatic weight recorder design originated in 1888 with the Streeter-Amet Company. The line manufactured grew with demands upon it until virtually every requirement of commercial weighing can be accommodated. The variety of special requirements appearing as business recovers indicates a future when the public conception of scales and their functions will be radically revised. In the mining industry as well as others which are becoming more or less active, wise and forehanded buyers with money to spend are buying not only better scales but also those whose functions tie the measurement of goods directly in with the relations between the customer and the cash drawer. For such purposes the automatic weight recorder is an essential instrument.

Reducing MINE CAR Lubrication Costs

By L. BALLARD*

THE MILLIONS of mine cars now in service comprise all types spanning the developments between steel shafts in a cast iron bearing to modern ball and roller bearing equipped wheels. In maintaining efficient service from these cars there is no more important factor than lubrication of the bearings. Whether they be of the plain or anti-friction type, lubrication is the deciding factor in determining ultimate life, time out of service for repairs and maintenance costs. Power costs are also vitally affected by lubrication as sticky bearings that are not efficiently lubricated put an unnecessary drag on mine locomotives which increases the power requirements and decreases the number of cars that may be hauled in one train.

In so far as lubrication is concerned mine car bearings may be separated into the two general classifications of plain and anti-friction bearings, although a number of different types are represented in each classication.

Plain Bearings.

Plain mine car bearings vary in design from those equipped with holes for applying the lubricant to the floating axle and cored cavity types. For many years it has been the practice to use black oil (commonly referred to as blackstrap) for bearings of this type and this is still the lubricating practice in many mines. The sole justification for using black oil for this service is that it is the cheapest type of lubricant available. However, the cost of lubrication includes more than the unit cost of oils and greases, as maintenance, labor and power costs are also involved.

When black oil is used on mine car bearings equipped with oil holes only a portion of the quantity applied reaches the frictional surfaces, the rest leaking over the outside of the wheels and dripping off as the cars are hauled. In addition to a wastage of lubricant, oil on the tracks decreases the traction of the locomotives and results in a fire hazard. This condition is also true of cavity type bearings as it is difficult to retain a fluid oil in the cavities without leakage and a considerable proportion of the oil applied is lost. When sufficient oil to assure proper lubrication does not remain in the bearing until the next oiling period, frictional losses increase and wear is accelerated.

This problem has been overcome through the use of suitable greases developed to meet the operating conditions common to mine cars. A grease is a mixture of oil and soap, the latter serving primarily to provide the desired consistency. Consequently, the quality and characteristics of a grease depend upon both the type of soap and the viscosity and quality of the mineral oil used. In general the suitability of greases for specific conditions is determined by the following four factors:

1. *Uniformity* of the grease and the absence of non-lubricating fillers.
2. *Consistency* of the grease to suit the method of application.
3. *Quality* of the ingredients composing the grease and the viscosity of the mineral oil used.
4. *Adaptability* of the grease to suit operating conditions. Greases can be made in any desired consistency and with any viscosity oil. For mine car bearings requiring a relatively fluid lubricant, an oil of good lubricating quality compounded with just sufficient soap to prevent leakage will usually result in a materially lower consumption of lubricant than possible with black oil only. The lubricating value of a grease is a function of the viscosity of the mineral oil used in compounding it and, therefore, a grease made with a heavy bodied oil will provide better lubrication with lower consumption than one made with a light bodied oil.

As greases usually cost more on a unit basis than cheap black oils, there is a natural tendency on the part of those responsible for purchasing lubricants to favor black oils for mine cars without considering other related costs, such as labor cost for application of the lubricant and maintenance cost. However, actual service has shown that correctly selected greases will result in economies, as illustrated by the following authentic example.

A large coal mine formerly used black oil to lubricate mine car journals. Although the cost per gallon of the oil used was very low, the lubrication cost was higher than desirable because of the necessity of daily application. The problem was studied and a grease made of the correct type to meet the service, but which cost considerably more on a per gallon basis than the oil formerly used, was installed. The result of this change was that it was only necessary to apply the lubricant once in twenty-four days instead of daily, the quantity of lubricant used and its cost over a period of time was lowered and wheel losses were reduced 25 percent.

* Supervising Industrial Engineer, Tide Water Oil Company.

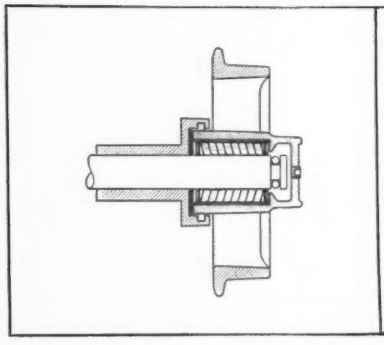


FIG. 2.—*Hollow, Spiral Type of Roller Bearing Applied to Mine Car Wheels With Ball Bearing for Thrust Loads.*

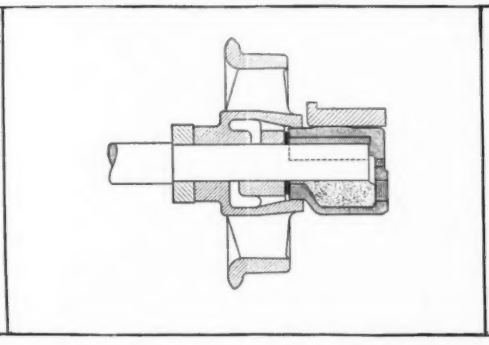


FIG. 1.—*Plain Bearing Mine Car Wheel.*

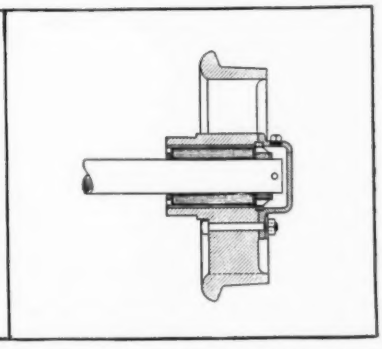


FIG. 3.—*Solid Cylindrical Roller Type of Mine Car Bearing Absorbing Thrust on Plain Bearing Surface.*

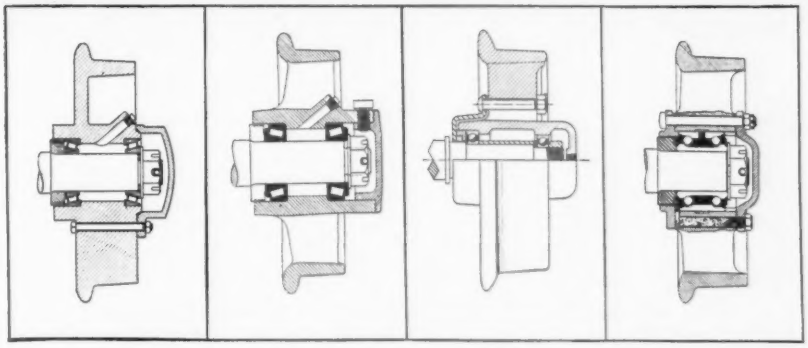


FIG. 4.—*Tapered solid roller bearing type of mine car wheel.*
FIG. 5.—*Another example of mine car wheel using tapered roller bearings effectively sealed and provided with grease reservoir.*
FIG. 6.—*Ball bearing mine car wheel using two row ball bearings, completely enclosed with provision for ample lubrication.*
FIG. 7.—*Mine car wheel using a double row type of ball bearing, completely enclosed and sealed with provision for long supply of grease.*

Anti-Friction Bearings.

Ball and roller bearing equipped mine cars are generally designed for grease lubrication as this type of lubricant is the most satisfactory for the operating conditions encountered. However, the results obtained in terms of frictional losses and maintenance are affected by the type and quality of grease used and the care exercised in its application.

Theoretically, the contact area between balls or rollers and their races is very small, but actually, because of deformation of the metal under pressure, the contact area is sufficiently large to distribute the load so that the unit pressure is not excessive. However, anti-friction bearings are generally subjected to greater unit pressure than plain bearings designed for the same service, although there is little sliding contact between the rolling elements and their races. Because of this, greases made with relatively heavy oils are more suitable than those made with low viscosity oils for mine car anti-friction bearings, and most manufacturers of such bearings specify a minimum viscosity of oil in the grease to be used. In addition to possessing high film strength, greases made with heavy oils also are less affected by heat and, therefore, do not tend to thin out and leak when subjected to the frictional heat generated in the bearing.

When grease is applied by grease guns it is common practice for those responsible for its application to force it into the housing until full. This is objectionable in that completely filling the housings results in considerably fluid frictional losses because of the churning effect of the balls or rollers on the excess grease. Not only does this raise the operating temperature of the bearing and increase the frictional losses, but it also tends to break down the structure of the grease and may cause ball or roller slippage with resultant wear. For grease gun application, the most suitable method of controlling the quantity of lubricant applied is to limit the oiler to a fixed number of turns or strokes of the gun handle, depending upon the capacity of the housings, and the establishment of a regular schedule to prevent greasing more often than necessary.

Wire Rope for Slope Or Incline Haulage

(*Concluded from page* 42)

enough additional service to pay for using it in the Lang lay construction as compared with the regular lay, non-performed wire rope. No general rule can be given to cover this, as the general arrangement of the equipment and the amount of wear that takes place in a given period of time will have an effect on the rope service, but the writer believes that there is an opportunity to increase rope service on Lang lay ropes on inclines by using preformed construction in place of the standard construction.

For inclines which use ropes smaller than 1 in., it is usually imperative that ropes composed of wires of coarser construction be used, such as 6x7 and 6x19 Seale construction.

The amount of wear on a rope will depend largely on the length of the incline, it being obvious that the end of the rope which travels the greatest distance in and out will take more wear than that portion which only travels a short distance from the drum. Accordingly, the maintenance of an incline rope will require the turning of the rope end for end at the proper time so that the end on the drum may be used and worn out, thus wearing both ends of the rope.

If it is possible to order rope longer than is needed so that a cut of several feet from the end can be made, additional wear can be obtained from the rope by paying out more rope on the drum end.

All of these points will, of course, be borne in mind and given consideration by the careful rope user who is desirous of obtaining the maximum results from his ropes.

Another point which must be given very careful attention on an incline is rope lubrication. Naturally with more rollers and more points of contact of the rope with sheaves and drums, wear will be more rapid unless ropes are kept thoroughly lubricated at all times. The lubricant that is applied should if possible be applied hot, and the rope should be clean and dry when the application is made. As received from the rope maker, the rope for incline duty should have a coating of heavy lubricant, and the additional lubricant should be applied before the original lubricant has been dissipated, thus keeping a film of lubricant on the outside of the rope at all times. We have seen some inclines where a wonderful job of lubrication has been done, and in those cases it invariably follows that the rope service obtained is maximum. On the other hand, where this is not done, two things happen: (1) there is more external wear; and (2), the rope is likely to become rusty not only externally but internally. When corrosion sets in, the wires lose their ability to slide one on the other, and become bonded together. As the flexibility of a wire rope depends upon the sliding of the wires with respect to each other when the rope is bent, corrosion causes the rope to lose its flexibility. When a rusty rope is bent, the wires, unable to adjust themselves by sliding, tend to snap off.

Lubrication is receiving more and more attention, and proper lubrication of his wire ropes will repay the rope user in increased rope life.

Picking the Brush For the Job

(*Continued from page* 40)

either the leading or trailing position. Very soft graphite grades, however, should not be operated in the trailing position, where greater tendency toward side wear is encountered than in leading operation.

Slip ring brushes are not subject to the demands of commutation. Consequently, selection of brushes for this service is usually made on the basis of current density to be carried, peripheral speed of the ring and composition of the ring. Brushes of very low apparent density (weight per unit volume) are often found preferable on rings of very high peripheral speed, such as turbo-alternator field rings.

Carbon, carbon-graphite and graphite-carbon grades are composed of amorphous carbon and graphite in various proportions. Most brushes of this type possess some degree of abrasiveness and are intended, primarily, for use on flush mica commutators or on undercut commutators where polishing action is required.

Graphite grades are composed principally of graphite, usually of the natural variety. They are adapted to high peripheral speeds but are not suited to conditions of great mechanical severity. Although low in friction, due to the inherent lubricating properties of graphite,

(*Concluded on page* 66)

Wheels of Government

(*Continued from page* 19)

ing, it is true, some minor amendments but still in much the form as when reported by the Senate Committee on Interstate Commerce on May 13. In the House of Representatives the Public Utilities Act of 1935 has been a storm center and as finally reported by Chairman Rayburn's Committee on Interstate and Foreign Commerce is a "regulatory" rather than a "dissolution" measure. It is anticipated that the bill will be subject to an embattled situation up to the time of its final enactment.

The Wagner National Labor Relations Act after passing the Senate by a vote of 63 to 12 on May 16, was reported by the Committee on Labor of the House of Representatives finally under administrative pressure given a rule and passed by the House on June 19 without a record vote. It has been reported that a majority of the members of the House were against the enactment of this bill but so adroitly was its legislative course conducted that it is about to become law. When this bill passed the Senate it was brought to the knowledge of the members that it would never be given a rule in the House. The information was to the effect that certain features of the Wagner National Labor Relations Act would be embodied in the new NRA bill. In this state of mind the members of the Senate voted 63 to 12 for its passage. The only amendment of material note which resulted from the meeting of the Senate and House conferees on the bill was that which struck out the words "or other unit" in Section 9 (b). This leaves the units for collective bargaining as the employer unit, the craft unit and the plant unit or subdivision thereof, thereby estopping the National Labor Relations Board from a rule that elections to determine unit control shall include the employes of more than one employer except only in the case of craft unions which have a very clearly defined scope. This bill will become law at an early date without regard to the fact that it has been passed upon as an unconstitutional measure by outstanding counsel.

The extension of the existing excise and import taxes, the majority of which were due to expire either on June 30 or July 31 of this year, has been expeditiously handled through H. J. Res. 324 introduced by Chairman Doughton (Dem., North Carolina) of the Committee on Ways and Means. Intensive efforts were made by the fur and gasoline industries to have the excise taxes on these two items either removed or reduced. In actual performance no reductions were granted and the resolution for the reenactment of the import and excise taxes was reported by the Committee on Ways and Means and passed by the House of Representatives. In the Senate the Committee on Finance reported the measure by reducing the House provision for a two-year extension to one year. At the time the resolution was reported from the Committee on Finance, a startling tax message was sent to the Congress by the President in which to quote Chairman Harrison of the Committee on Finance. The outstanding items are as follows:

"The first is with reference to graduated taxes on corporations, beginning, as suggested in the President's message, at 10¾ percent on the smaller corporations and running as high as 16¾ percent on the larger corporations.

"Secondly, in the present law relating to incomes of $1,000,000 and more, the brackets cease at $1,000,000. A person pays at the same rate on an income of $10,000,000 as on an income of $1,000,000. As suggested in the President's message, he desires that an increase in surtaxes on the larger incomes shall be written into the law. That is the second proposal.

"The third suggestion is to put a tax on net inheritances. Under the present law, as the Senator will remember, the tax ceases at 60 percent. After an estate is split up and the inheritances go to the individuals, then under the President's suggestion we would apply a tax on the larger inheritances."

The message was hailed publicly as a "share the wealth" or "redistribution of wealth" proposal and was viewed by many as a political gesture. For a few days, the passage of H. J. Res. 324, the re-enactment of the import and excise taxes was very much confused as it was asserted that the President desired the new tax measures contemplated in his message to be enacted as amendments to the excise and import resolution. As the result of conferences between the White House and the administration leaders at the Capitol, it was decided that the new taxes are to be made the subject of treatment by the Committee on Ways and Means in the regular order of the development of a revenue measure and upon this decision H. J. Res. 324 was passed by the Senate and sent to conference. The conferees agreed upon a two-year extension for the excise and import taxes and both Houses approved the report, thus providing that the measure may be approved by the President before June 30, the date on which these taxes would have otherwise expired.

The Guffey Federal Coal Control bill, S. 2481, as rewritten and re-introduced, was finally brought up for hearing before the Committee on Ways and Means as the Snyder Bill, H. R. 8397 on June 17. The Sub-committee hearing this bill consists of the following:

Sam B. Hill, Washington, Dem.; Cullen, New York, Dem.; Vinson, Kentucky, Dem.; Cooper, Tennessee, Dem.; Treadway, Massachusetts, Rep.; Crowther, New York, Rep.; Woodruff, Michigan, Rep.

The Committee has given particular attention to the question of the constitutionality of the bill which is a matter very seriously in doubt. There is grave question as to the propriety of the bill under the commerce clause; also as to the propriety of using the taxing power to enforce compliance with the code which is set up in the bill; and further as to the constitutionality of Title II which provides for the purchase of marginal coal lands and mines by the Federal government for purpose of retirement from production and proposes a tax to be levied upon each ton of coal produced to carry the cost of such purchases. Counsel for both proponents and opponents of the bill have argued the constitutionality features and representatives of coal producers have appeared for and against the bill with reference to the practical problems involved in the marketing provisions.

S. 2536 providing for the suspension of assessment work on mining claims was approved by the President June 13 in form identical with the enactment of 1934 with the exception that Alaska is not now subject to the suspension of assessment work on unpatented claims. The text of the bill as approved is reproduced on page 20.

Picking the Brush For the Job

(*Continued from page* 65)

most brushes of this class have a mild abrasive or polishing property. Certain graphite grades of very high transverse resistance have excellent commutating properties.

Electro-graphitic grades are produced by baking in electric furnaces at an extremely high temperature which converts amorphous carbon into graphite. This extreme temperature volatilizes all materials other than carbon in the brush composition and produces a material practically free from abrasive property. Electro-graphitic brushes, as a class, are characterized by high contact drop, excellent commutating properties and low coefficient of friction. They have a wide field of application on practically all types of equipment but, due to lack of abrasiveness, are preferably used on commutators with undercut mica. Heavy duty, D. C. power service is best handled by electro-graphitic brushes.

Super-baked grades are also baked in the electric furnaces but at lower temperature than electro-graphitic grades. They are accordingly somewhat harder, have more polishing action, and are adapted to conditions of appreciable severity, such as those encountered on series type D. C. motors. Commutator mica should preferably be undercut where super-baked brushes are used.

Metal-graphite brushes are much lower in contact drop than any of the types previously described. They are intended only for slip rings and for low voltage commutating equipment.

As an aid to picking the brush for the job, a table is given below which shows the type of brush generally preferred for different types of equipment used in mine service. Selection from grades of the types indicated should be made on the basis outlined in the earlier part of this discussion.

PERSONALS

A. E. Bendelari, president, The Eagle Pitcher Lead Company, has been elected to the Board of Directors of the Lead Industries Association.

S. R. Elliott, general superintendent, Cleveland Cliffs Iron Company, has returned to Ishpeming after a trip to Texas.

John C. Haddock, president, Haddock Mining Company, has been elected vice president and manager, Alden Coal Company.

Jesse F. McDonald, formerly of Leadville Colorado, has moved to Denver, Colorado.

M. D. Harbaugh, secretary of the Tri-State Zinc Ore and Lead Producers Association, with Mrs. Harbaugh, were in Washington for several days during the month.

Wade Kurtz, tax attorney from Miami, Oklahoma, was a Washington visitor during the month.

Charles B. Officer in addition to his former duties as chief engineer of The Sullivan Machinery Co., has recently been appointed vice president. Mr. Officer expects to spend considerable time at the Claremont, New Hampshire offices of the company.

Guy Hunner of Iron River, and **Ocha Potter** of Ahmeek, well-known Michigan mining men, were recently elected officers of the Isle Royale National Park Association at a conference in Escanaba, Michigan. Mr. Hunner, superintendent of the Zimmerman mine of the M. A. Hanna Company, was elected president of the association, and Mr. Potter, Calumet and Hecla superintendent, was elected vice president.

The association has been formed with the primary objective of securing title to lands on Isle Royale in Lake Superior, and conveying the same to the Federal authorities at Washington for national park purposes.

Dr. W. O. Hotchkiss, for the past ten years president of the Michigan College of Mines, has been elected president of Rensselaer Polytechnic Institute, Troy, New York.

James F. Callbreath, secretary emeritus, The American Mining Congress, is at his ranch at Alamosa, Colorado. With Mrs. Callbreath he is planning an extended stay in the West.

Robert C. Stanley, president of The International Nickel Company of Canada, Limited, was awarded the honorary degree of Doctor of Engineering by Stevens Institute of Technology at its sixty-third commencement exercises held in the William Hall Walker Gymnasium Building at Castle Point. Mr. Stanley is an alumnus, having been graduated in 1899 with the degree of Mechanical Engineer. On December 14, 1933, he was elected to serve as a member of the board of trustees.

WM. B. DALY

Manager of Mines, Anaconda Copper Mining Co., Butte, Mont.

Chairman, Program Committee, which at present is developing program for the annual Metal Mining Convention of The American Mining Congress, scheduled for the Palmer House, Chicago, Ill., Sept. 23-27, 1935. With Mr. Daly is a committee representing every mineral producing district in the United States.

At the presentation of the **E. H. Harriman Memorial Medals** of the American Museum of Safety to Class I railroads for outstanding safety achievement during the year 1934, Nevada Northern Railway Company, subsidiary of Kennecott Copper Corporation, received the bronze medal for Group C roads operating less than 1,000,000 locomotive miles. **Erle V. Daveler**, treasurer, received the medal on behalf of the Company at a luncheon tendered by the American Museum of Safety at the Union League Club, **D. C. Jackling** is president of Nevada Northern and **George L. Hickey** is vice president and general manager.

This is the second time this road has achieved recognition for its safety record, having received the same award for the year 1929.

On May 13, 1935, Nevada Northern also received a bronze plaque from the National Safety Council as an award for safety achievement during 1934.

Archibald Douglas, well-known New York attorney, closely affiliated with the copper industry, was a Washington visitor June 26.

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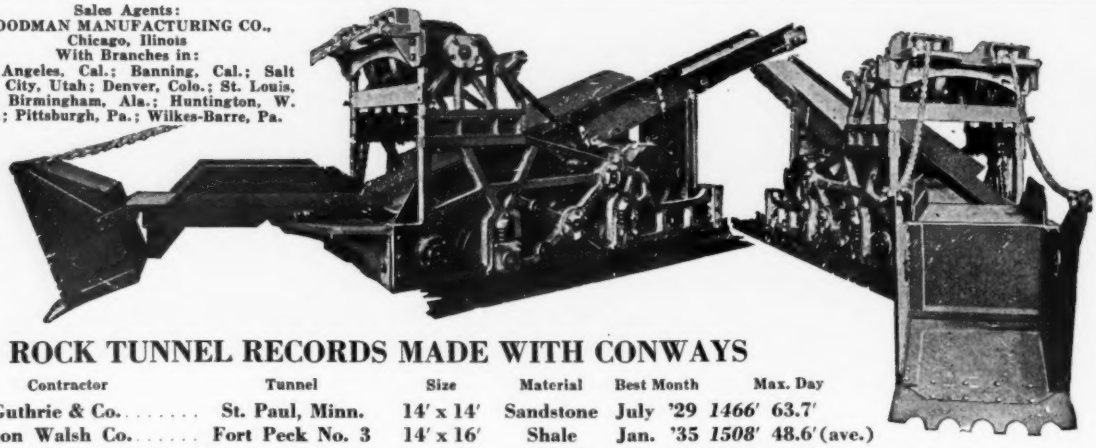

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Utah Construction Co.	W. Iron Mountain	20′ x 20′	Gravel	Nov. '33 *1027′*	46.5′
L. A. Dept., Water & Power	Mono Basin	12′ x 12′	Rock	Apr. '35 *1219′*	72′
Walsh Construction Co.	Whipple Mountain	19′ x 19′	Rock	Mar. '35 *1084′*	55′
Dixon-Bent & Johnson	Pasadena	12′ Circ.	Sand and Gravel	Apr. '35 *1504′*	17.7′ (ave. shift)

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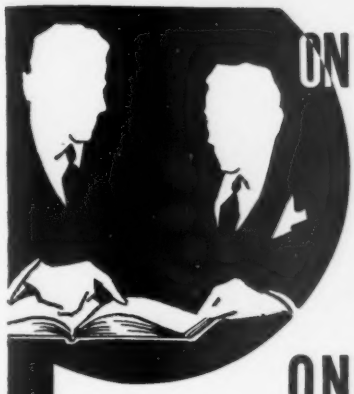

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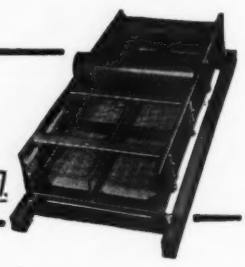

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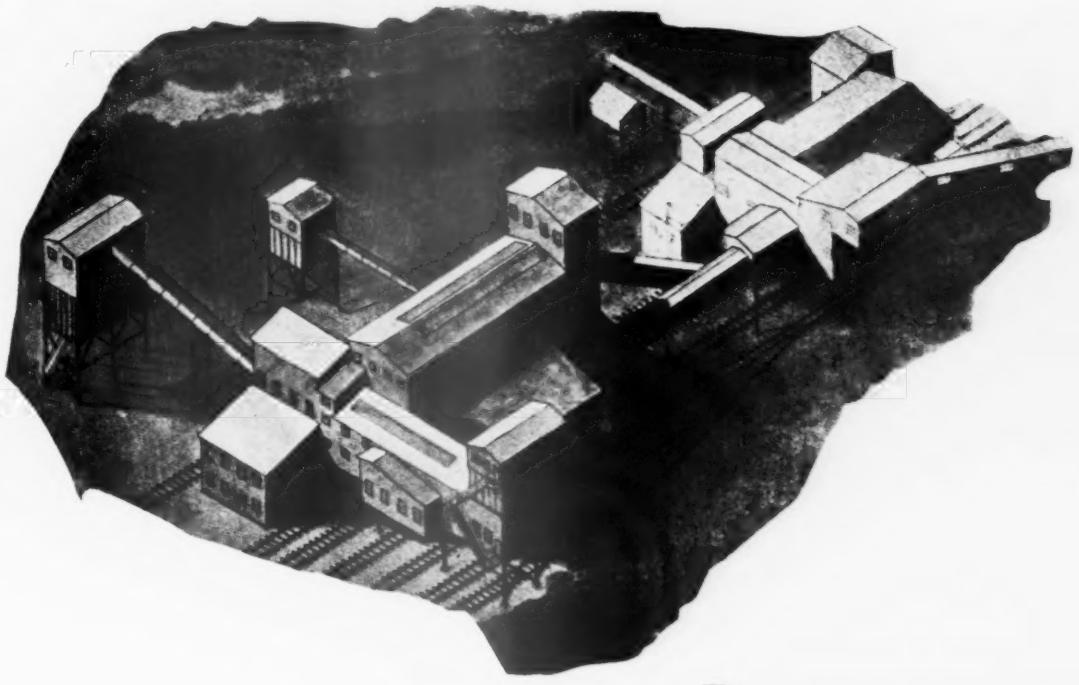

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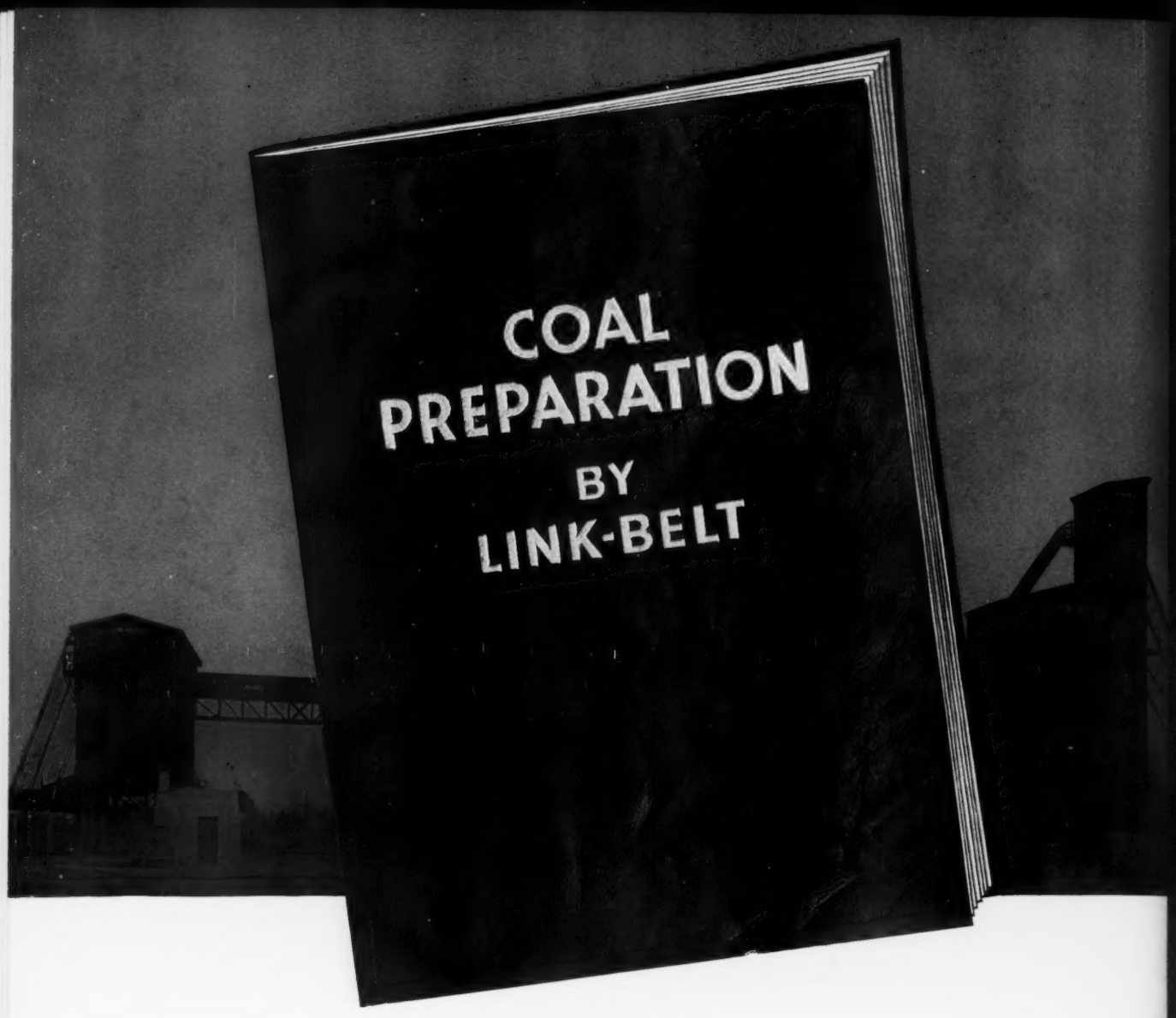

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